MACHINERY

December, 1911

FOUNTAIN PEN MANUFACTURE

METHODS EMPLOYED BY THE L. E. WATERMAN CO. IN THE MANUFACTURE OF FOUNTAIN PENS

By DOUGLAS T. HAMILTON*

THE average user of a fountain pen little realizes the accurate work and care which are necessary to produce it. The turning of the rubber parts presents difficulties which can only be mastered by careful and accurate workmen —specialists in this line. The methods employed in the making of the gold pen point are also unique, and are well worth recording. Mr. F. P. Seymour, advertising manager of the L. E. Waterman Co., has kindly furnished us with the necessary photographs and information, which enables us to give MACHINERY's readers the opportunity of learning how fountain pens are made.

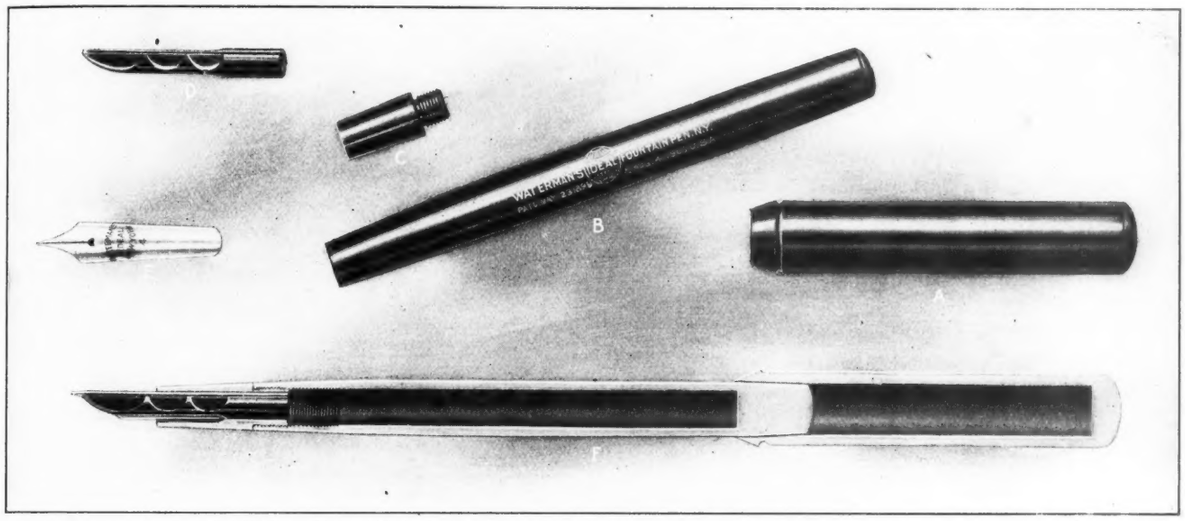


Fig. 1. Component Parts of Waterman's Ideal Fountain Pen. A is the Cap; B, the Barrel; C, the Point Section; D, the "Spoon" Feed; E, the Pen Point; and F, a Sectional View of the Assembled Parts

The L. E. Waterman Co. produces one and one-half million fountain pens a year, which requires the combined output of three large factories. The greater number of the rubber pen parts are made at the factory in Seymour, Conn., and the gold pen points in the fully equipped plant in New York City. The factory located at St. Lambert, P. Q., Canada, is required to supply the Canadian field exclusively. There are about 650 men and women employed in all three factories.

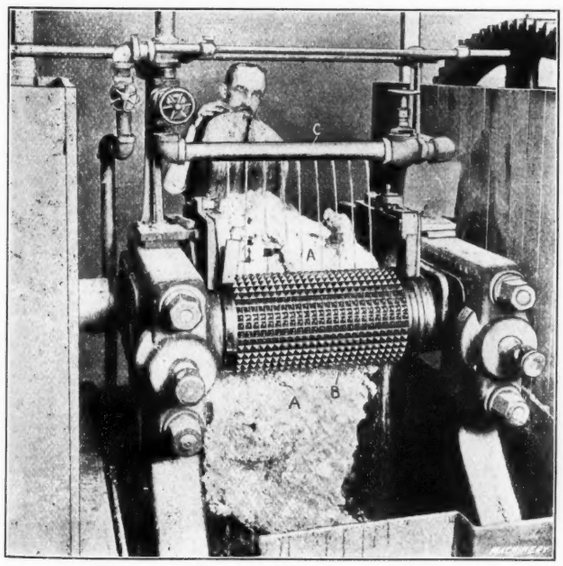


Fig. 2. Grinding and Washing the Crude Rubber "Biscuits"

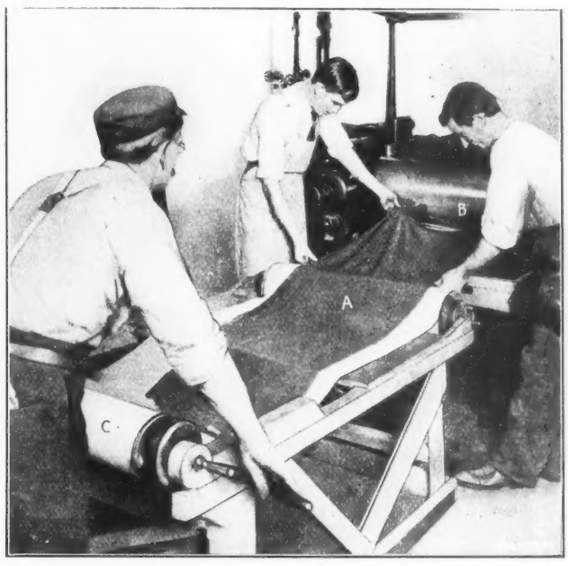


Fig. 3. Rolling the Rubber out into Sheets of the Required Thickness

Obtaining the Crude Rubber Gum

The crude "Para Beni-Bolivian" rubber gum, as it is called, is obtained from *Hevea Brasiliensis*, a large tree 60 feet high, which grows on the banks of the Beni River in Bolivia. These trees are tapped by cutting a deep horizontal slit near the base of the tree and a vertical one extending from it up the trunk; from both sides of the vertical incision slits are cut, at short distances apart, in an oblique direction. The tapping is done in the dry season, between August and February, in the evening, and the "milk," as it is called, is

* Associate Editor of MACHINERY.

collected the following morning, in small shallow clay cups which are fastened below the horizontal incision by a piece of soft clay. When these cups are full, their contents are poured into a larger receptacle. Each tree yields only about two ounces of milk a day, and as the L. E. Waterman Co. uses forty tons of rubber per year, this means that upward of 3000 trees are required to produce sufficient gum—an industry of considerable magnitude in itself.

To produce the rubber, a wooden stick about three feet long, provided with a flattened clay mold at the end, is dipped

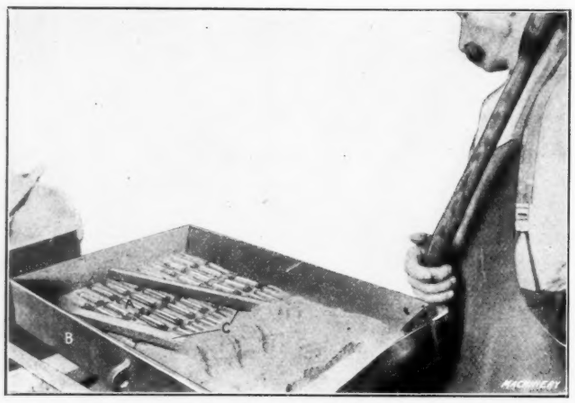


Fig. 4. Covering the Rubber-coated Arbors with Powdered Soapstone previous to Vulcanizing

into the receptacle containing the gum, or milk, the liquid spreading itself evenly on the mold. The milk is then carefully dried by holding the mold over a white vapor produced by heating certain oily palm-nuts, the stick being rotated so that the milk is evenly distributed and formed into a sort of gum. Each layer of gum is allowed to become firm before any more milk is added to it. An experienced man can make five or six pounds of gum an hour. The rubber cakes, or "biscuits," thus formed, are slit open in order to remove them from the mold, and are then hung up to dry. The crude rubber is brought down the Beni River, is inspected by a

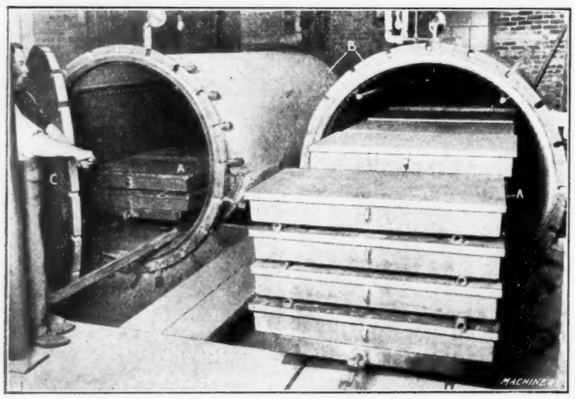


Fig. 5. Placing the Iron Boxes containing the Rubber-coated Arbors in the Vulcanizing Ovens

Waterman representative, and is trans-shipped from the seaport Para to the Waterman factory at Seymour, Conn., at which place the crude rubber is manufactured into the rubber pen parts.

Washing and Grinding the Crude Rubber

After the gum has soaked in hot water for about two weeks it is taken to the grinding machine shown in Fig. 2, where it is passed through 15-horsepower grinding rolls. These grinding rolls *B*, one of which is shown, chew up the rubber *A*, and cold water, forced out of the pipe *C*, washes the dirt out of it. The rubber is put through these rolls several times until it is cleansed and thoroughly "masticated." After washing, it is placed in a heater, kept at a temperature of about 135 degrees F., where it remains a couple of weeks. Then it is put through another pair of rolls where it is again ground and the sulphur is mixed in. One of the rolls travels faster than the other, which tends to strip and separate the rubber sufficiently to allow the sulphur to work in. The correct quantity of sulphur is here mixed in, the operator tearing the rubber off as it comes through, and passing it through again. This operation is repeated until the sulphur and rubber have been thoroughly mixed. The mixing rolls are heated so that the rubber can be properly manipulated.

The rubber is now passed through the sheeting rolls, shown in Fig. 3, where it is rolled out into sheets about 1/32 inch thick. As the rubber sheet *A* passes through the rolls *B*, it is laid on cotton cloth in which it is wound. This cloth prevents it from sticking together and also keeps it clean. It is then wound on a roll *C*, so that it can be easily unrolled when cutting it up into strips for rolling on the arbors. The rolls *B* are heated by means of steam pipes passing through them as is the case in the previous operation. The rubber is kept warm and plastic throughout all these operations.

The sheets are now ready for cutting up and rolling on mandrels, which form the barrel and cap of the fountain pen. This is accomplished by boys who use heated mandrels, cut the rubber into strips sufficient for a pen cap or barrel, and roll it on these arbors to the required diameter, the rolling being done on a heated smooth steel bed. Before starting to roll the rubber on the arbor, a rubber plug of the same di-

Fig. 6. A General View of the Rubber Turning Department

ameter as the arbor is stuck on the end of it, which forms the end of the barrel or cap, as the case may be, thus converting it from a tube into a shell form. Foil is then wound over the rubber to prevent the sulphur from "boiling" out, while being vulcanized.

Following this, the arbors *A* with the rubber and foil wound on them are placed in the steel box *B*, as shown in Fig. 4, an even layer of powdered soapstone being first deposited in

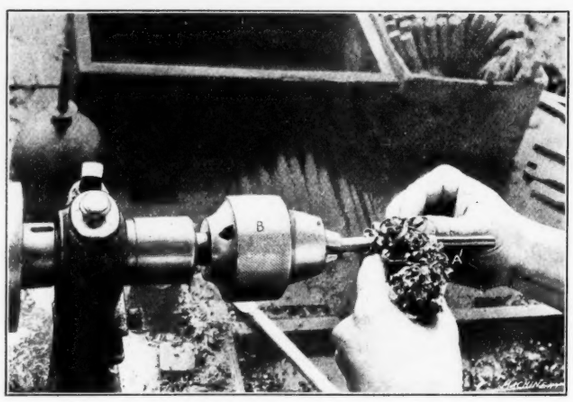


Fig. 7. Rough-turning the Rods for the "Feeds"

the box. Then the rubber-coated arbors are placed, as shown in the illustration, far enough apart so that they will not come in contact with one another, after which two wooden strips *C* are laid on top of them. More powdered soapstone is now put in, and the box is filled to the height of the top of these sticks, which act as a gage, so that the soapstone will be of an even depth. The soapstone is then tramped hard to form a mold for the parts during vulcanization. A steel cover is now locked on the box, when it is ready for placing in the vulcanizing oven.

Vulcanizing the Rubber Pen Parts

Rubber before vulcanizing is void of shape and is of little commercial value. Until the advent of this discovery by Charles Goodyear in 1853, rubber was not used to any great extent. Vulcanizing consists essentially of mixing the required amount, about thirty-three per cent by weight, of sulphur with the crude Para rubber, and keeping this in a receptacle, which is heated to about 300 degrees F. for about fourteen hours. Of course the exact time that the rubber should be left in, to have the desired resiliency and hardness, depends on the size of the parts being vulcanized. The operator not only has to watch the pressure gage to determine the temperature, but he also has to follow the predetermined lines on a recording thermometer. The smaller the proportion of sulphur in rubber, and the lower the temperature used, the softer and more pliable the vulcanized rubber will be. For fountain pens, the rubber has to be sufficiently hard so that it cannot be easily bent out of shape, and still have sufficient resiliency so that all joints will be ink-tight. It also has to be workable.

After the rubber pen parts have been rolled on the arbors and placed in the steel boxes *A*, the latter are conveyed to the vulcanizing ovens *B* shown in Fig. 5. Here they are placed one upon the other, iron tubes separating them, on a truck which is rolled into the oven. The large iron door *C*, which the operators, at the left of the illustration, are grasping, is then placed on the end and held by swinging bolts. Steam is turned on and escapes into these ovens, and the temperature is gradually brought to about 300 degrees F. After the rubber has been vulcanized, the door is taken off and the car carrying the steel boxes is rolled out, when the rubber is stripped from the mandrel in a special gripper machine. The rubber parts are then ready for turning, after they have been sawed to the desired lengths.

The process of rolling the rubber just described is that generally used for making the cap and barrel, but where long rubber tubes are to be made, they are extruded in a special machine.

Turning the Rubber Pen Parts

Vulcanized rubber is not only used for making fountain pens, but it is also employed to a considerable extent for other purposes, especially in the manufacture of electrical apparatus. The rubber used for fountain pens, however, is slightly softer than vulcanite, which is employed in the manufacture of electrical apparatus, but it presents just as difficult a problem in turning. No automatic machines, whatever, are used in the production of the rubber parts (with the exception of chasing), each part having to be made separately by hand, which requires the aid of experienced workmen. A general view of the rubber-turning department in the Seymour shops of the Waterman Fountain Pen Co. is shown in Fig. 6, where the turners can be seen at work making the rubber parts of the pen.

Making the Rubber Cap

The rubber cap, shown at *A* in Fig. 1, is made from a cup, as has been previously stated, and for the rough-turning operation is placed on an arbor *B* as shown in Fig. 8. The turning is accomplished with a flat hand tool *C*, the operator holding it in one hand, guiding it with the thumb of the other hand, and placing the first finger of the left hand at the back of the work to prevent the cuttings from obscuring his view of the point of the turning tool. The free end of the arbor is supported by the tailstock center. The tool *C* is held on a rest *D*, the cutting edge being slightly above the center of the work. In this operation the foil, which was used when vulcanizing to prevent the sulphur from "boiling" out, is also removed. The cap is now finish-turned with hand tools, after which it is reamed taper with a flat reamer made from Crescent tool steel. This is done so that the hole in the cap will fit the tapered ends of the barrel.

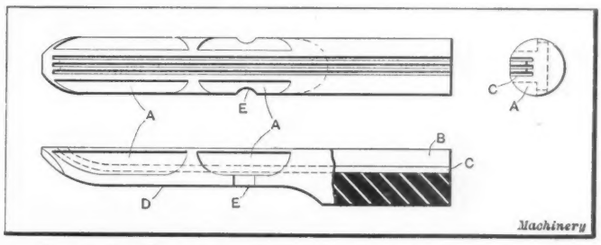


Fig. 11. The "Spoon Feed" which conveys the Ink to the Pen Point

Fig. 8. Rough-turning the Rubber Cap

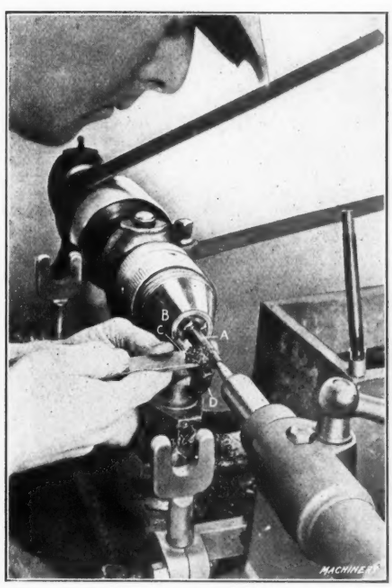


Fig. 9. Tapering the Ends of the Rubber Barrel

Fig. 10. Turning and Threading the Point Section

Making the Rubber Barrel

The rubber barrel shown at *B* in Fig. 1 is rough-turned in a lathe in a similar manner to the cap shown in Fig. 8. The next operation on the barrel is to finish the two tapering ends; one end must fit the taper on the point section, while both ends must fit the tapered hole in the cap. This is accomplished as shown in Fig. 9. The barrel *A* is held in a chuck *B* in a small turning machine, and the operator, by means of a flat hand tool *C*, turns down the tapered ends to the required taper and diameter. The tool *C* is held on a rest *D*, and the taper is governed entirely by presenting the tool at the required angle. The tool is made from ⅛- by ¾-inch Crescent tool steel hardened "glass-hard." Every time a cut is taken this tool is "touched up" on an Arkansas oilstone, so that the cutting edge is kept as "keen" as possible. If the tool is the least bit dull, it produces a ragged edge and also burns the work, discoloring it somewhat. While tapering the front end, the tailstock center is placed in the hole.

After the front end has been turned, the barrel is reversed and the rear end is turned taper and rounded off. The barrel is then ready for reaming and tapping. The reaming is done with an ordinary flat reamer in a speed lathe, while the tapping is accomplished with a tap provided with only two rows of teeth, or, in other words, two cutting edges, the tap being practically flat. This operation is done in a speed lathe which is provided with cross belts, so that the spindle can be reversed for backing out the tap. The operator holds and guides the tap by his right hand, a dog being fastened to the tap so that he can grip it securely.

Making the Point Section

The point section, shown at *C* in Fig. 1, is that part of the fountain pen which holds the nib and the feed. It is made from tubular rubber, produced by the extrusion process previously mentioned. The first operation is to rough-turn the outside. Then it is placed on an arbor, as shown in Fig. 10, where that part on which the thread is to be cut is rough- and finish-turned. The threading is also done while the point section *A* is located on the arbor *B*, and is accomplished with an ordinary flat chaser similar to that used by brass finishers.

The type of turning rest used for holding turning tools is clearly shown in this illustration. It consists of U-shaped supports *C* in which a round bar *D* rests. The turning tool *E* is fastened to the bar *D* and is supported on the front end by the rest *F*. The bar *D* slides freely in the U-shaped supports *C*, which can be set so that the tool will turn tapering by changing the position of the slide-rest *G*, holding one of the supports. The thread on the point section must be perfect as regards shape, that is to say, it must be of the same included angle as the thread in the barrel so that the ink cannot leak down past the threads; it is also required to fit tightly in the barrel. After the thread has been cut, the front end is reamed to fit the feed and pen point, after which the external diameter is taper-turned to suit the taper on the barrel, the turning being accomplished in the manner previously described. These rubber turning lathes are rotated at about 2000 revolutions per minute.

Fig. 12. Rough-polishing the Rubber Barrels on a Wet Carpet-wheel Buff

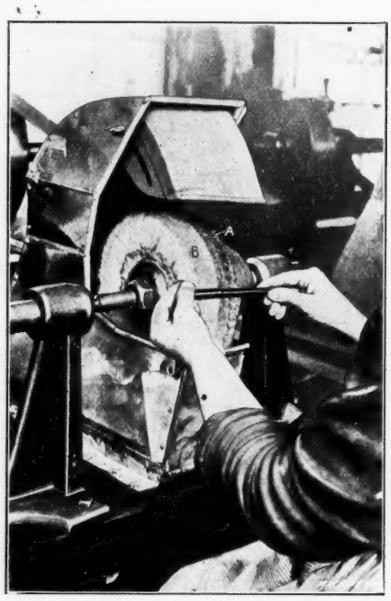


Fig. 13. Finish-polishing the Rubber Pen Parts, on a Rouge-covered and Dry Buff

Fig. 14. Riveting the Clip-cap on the Rubber Cap

Making the Feeds

The "spoon" feed, shown at *D* in Fig. 1, which conveys the ink from the barrel to the pen point, is made from solid rubber, and is cut to the required length from a rubber rod about three feet long. The cut rod is grasped in a chuck *B* as shown in Fig. 7. The turning is accomplished by a small tool made from Crescent steel, held in a holder, which the operator holds in his right hand, guiding it by the left hand as is clearly shown in the illustration. The feed is really the most important part of the fountain pen, with the exception of the pen point, and requires very accurate work. After rod *A* is turned it is again cut into short lengths. Then the pockets *A*, shown in Fig. 11—the peculiar feature of the Waterman fountain pens—are cut. The feed is held in a small fixture, and two cutters, similar in shape to an end-mill, are brought in from each side and fed to the proper depth, and then the table carrying the feed is traversed the required distance. Both pockets on each side are cut in this manner.

Following this operation, the air vent *B* is made with an ordinary slitting saw about 3/64 inch wide, the slit being made about 1/16 inch deep. The next operation is to cut the ink fissure ducts. When writing, the ink passes down these fissures *C*, while the air passes up through the slot *B*, so that every drop of ink in the pen can be used. The feed is now taken to another milling fixture where it is clamped, and the bottom surface *D* is milled to the required shape. This is done in a small miller somewhat similar in action to a profiler, with the exception that the cutter is held in a horizontal plane instead of in a vertical position. The movement of the head holding the milling cutter is controlled by cam-faced guides of the required shape. The small air ducts *E* are produced with a round file. The rubber pen parts are held to a limit of 0.001 inch, being gaged by the operator when turning. They are also again gaged by several inspection departments.

Polishing the Rubber Parts

All the rubber parts of the pen have now been made, but are in a rough condition—not polished. The first polishing operation consists in holding the rubber pen parts on arbors, and turning them around by hand while they rest on a wet carpet-wheel buff, shown in Fig. 12, on which water is flowing. Ashes and powdered pumice stone are applied to this carpet buff *A*, which removes all tool marks, but does not give a glossy or polished appearance.

The next operation consists in polishing the assembled rubber parts on a cotton-wheel buff as shown in Fig. 13. The side *A* of this cotton-wheel is coated with rouge, and is slightly dampened, while the other side *B* is dry, and is not covered with any sort of polishing material. The operator holds the pen in both hands, as shown, passing it back and forth over this cotton buff. In the illustration the operator is holding the pen on the polishing buff. When roughing down on the buff *A*, coated with rouge, the pen is held in a vertical position and is moved up and down on the face of the wheel.

After polishing, the pen is tested to see that it does not leak. The assembled pen, without the feed or pen point, is located in a tank of water, and a syringe, which has a rubber tube that fits tightly in the point section, is inserted in it. Then pen and tube are placed in the water, and the bulb is

pressed, forcing air into the pen. If any bubbles are seen to rise in the water, it is evident that the pen leaks, and it either has to be repaired or discarded. This test is sufficient to expose any imperfections in the fitting of the manufactured rubber parts.

Stamping the Name on the Barrel

As far as the manufacturing operations are concerned, the holder itself is complete, with the exception of having the name stamped on it. This is accomplished in the special device shown in Fig. 15. The barrel is placed on an arbor on which it is clamped, this arbor being connected to a square slide *B* working against the tension of a spiral spring. The barrel rests between two rolls *C* and *D*, the latter roll having the stamp cut in relief, which is to be reproduced on the barrel. The handle *E* for operating the rolls is placed in the roll *D*, the latter being connected to the roll *C* by a block chain. The groove in the roll *C* is tapered slightly to correspond with that on the barrel, and fits it snugly. The illustration shows a barrel just after the stamping operation, the handle *E* being moved to the left when stamping. The rolls are held on sliding bases, *F* and *G*, which can be adjusted back and forth by the thumb-screws *H* and *I*, so that pen barrels of various diameters can have the name rolled on them in this same fixture.

Chasing the Barrel and Cap

The chasing on the Waterman fountain pens is accomplished in special chasing machines, one of which is shown in Fig. 16. The barrel or cap, as the case may be, is placed between centers. In the illustration, six barrels are being chased. The holes in these barrels *A* are placed on close-fitting arbors which have spur gears *B* fastened on the rear end. The other end of the barrel rests in a support *C*, which is counterbored to suit, and in which the barrel rotates. These plungers or supports *C* are provided with springs, so that when the thumb-screws *D* are loosened, the plunger will spring back, allowing the barrel to be removed.

As before mentioned, each arbor that carries a barrel is provided with a spur gear. These spur gears, in turn, are all driven from one central gear, which is located on the arbor *E*, the ratchet plate *F* also being held on this same

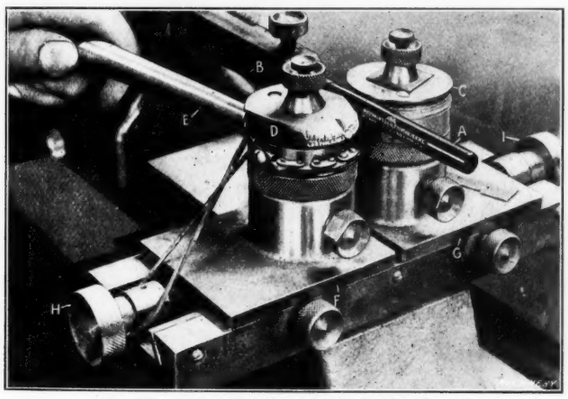


Fig. 15. Rolling the Name in the Rubber Barrel

arbor. A threaded sleeve fitting on the arbor *E* is cut away for part of its circumference. The full part prevents any chasing being done where the name appears on the barrel. When chasing the caps, this sleeve is entirely removed, so that the chasing may be done completely around the cap.

The machine is driven by a belt running on the pulley *G*, which is provided with a tooth clutch. Another tooth clutch on the shaft at the rear meshes with this tooth clutch on the pulley, so that when they are connected the machine will operate. The rear shaft is provided with an eccentric which runs in an elongated slot cut in an arm attached to the moving table of the machine. As the pulley rotates it moves the table back and forth by means of the eccentric, and as the table moves back and forth, a spring-actuated slide *H* comes in contact with a cam block *I*, both of which are beveled as shown. This action forces the spring-actuated slide in, and as it carries a ratchet which meshes with the disk *F*, the latter is rotated. As this disk is connected to the central screw *E*, and as the screw is geared up with all of the arbors, it is evident that they all must rotate in unison.

Now directly over the center of each arbor or pen barrel is a "tool-holder" *J*, in which is held a black diamond, similar to those used in truing emery wheels except that they are finished—having a sharp cutting edge. All sorts of steel cutters have been tried without success. A steel tool will work for a short time, but as soon as it becomes dull, it tears the rubber and makes a very dirty-looking job. The head *K* in which these diamonds are held is fulcrumed at *L*, and is compressed by the plate spring *M*. Held in the front end of the head is a stud *N* carrying a roller *O* which works on the sleeve previously mentioned, and also a stud *P* which works on a rack *Q*. This rack lifts the head *K*, so that the spacing between each chased space is made.

The pattern is controlled by means of a cam *R*, held on the central stud *E*. This cam operates the rack *Q*, changing its

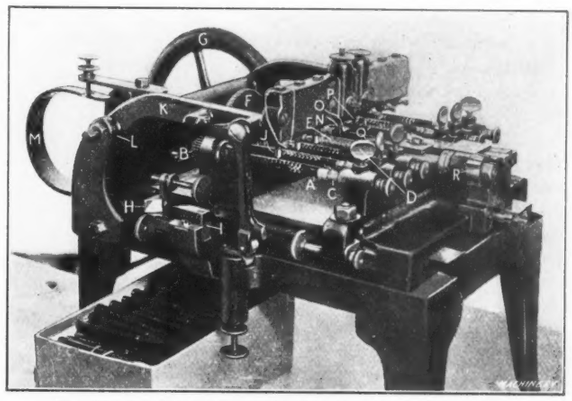


Fig. 16. Special Automatic Machine for Chasing the Rubber Barrel and Cap

position as the rubber barrels are rotated, and by this means the zigzag chasing effect is given to the barrels. It can, therefore, be seen that for each revolution of the driving gear, or, in other words, for each revolution of the pen barrel, six barrels are completed, the time required being six minutes.

The chasing on the barrel, as previously mentioned, does not continue entirely around its circumference. This is accomplished by a sleeve held on the central screw *E*, which lifts up the head *K*, by means of the roller *O*, when it rests on the full portion of the sleeve. Here the machine cuts "air" until the arbor has turned around sufficiently to allow the roller to drop off the sleeve, when the chasing again commences. The machine is stopped automatically by means of a finger attached to the ratchet plate *F*, which comes in contact with a spring-actuated slide, normally kept in contact with an arm, which, in turn, is fastened to the tooth clutch. As soon as this finger touches the slide, it depresses a spring, and at the same time pulls the former from the cam on the lever, thus allowing the latter to be acted upon by another spring, which disconnects the clutch, thus stopping the machine.

Putting on the Clip-cap

The clip-cap, which is used for holding the pen in the pocket, is held to the cap by means of a twin rivet. The holes for the twin rivet are drilled in an ordinary drill press, after which the rivet is placed in a slotted arbor, the latter being inserted in the cap, then pushed up forcing the two prongs of the rivet through the holes. The cap is then taken to the foot-press shown in Fig. 14, where the operator places it on an arbor. Here the cap *A* with the arbor in it is laid in a groove cut in a lead block *B*, the latter being held in a cast-iron shoe *C*. The riveting is done with a small punch *D*, provided with a circular depression in its lower end, the operator simply pressing the foot-treadle, bringing the punch down on the top of the twin riveting prongs, and thus setting them.

* * *

If some men applied themselves to their work with only half the energy which they display in trying to find something to fuss about, they would not have to work half as hard as they do.

CONDITIONS IN THE FAR WEST

By CARROLL ASHLEY*

In the following article the writer intends to give some of his opinions of the difference between working in the shops on the Pacific coast and in those in the East. The reason for doing this is that many mechanics come to the Pacific coast uninformed of the real conditions there, and hence frequently meet with difficulties or disappointments. Few people in the East are well informed on the exact conditions in California, because advertisements mis-state and over-state the advantages gained by living in the West. In referring to the conditions on the Pacific coast, the writer will refer particularly to those in Los Angeles. All factors involved, however, cannot be considered without bringing in some details which are not strictly of things mechanical, such as climate, temperature, etc. A short visit to the Pacific coast will not give to most people a clear idea of the conditions. Although these conditions may not be in all respects such as expected, it is true that if one has lived here a year, one usually gives up the idea of going back East—to stay.

Toolmakers working in tool- and die-rooms, doing fine and complicated work, and having steady employment, should not think of leaving it for a similar job in Los Angeles. There are exceedingly few shops in or near this city where there are opportunities or facilities for doing "close" work. In this city of 350,000 inhabitants, those who have good positions are keeping them with hopes of resigning only in favor of the coming generation. A first-class mechanic used to the fine toolmaking of the East has no chance here unless he is able to adapt himself to the methods of doing work here. The writer has seen many ex-foremen, chief draftsmen, and first-class tool- and die-makers who have left the East and expected upon their arrival here to "land" good jobs, but who have had to be satisfied with work in garages and numerous small job shops, where work is done very cheaply, and the mechanic is so "hustled" that it soon drives him to start a chicken ranch.

There are a large number of small jobbing shops around the city, the greater number of which are poorly equipped for doing all the kinds of work that they undertake. The work in these shops will vary from turning automobile crankshafts to the milling of all kinds of gears, including those of metric pitch. An extensive business is done in experimental work, generally in inventors' ideas, which must be gotten out cheaply "to see if it works." The writer once had an experience of making a fountain ruling pen for draftsmen, which was promised in thirty hours. In that time it was hardly possible to make the cutters and end mills for the hinge part, to say nothing of the internal (I almost said infernal, which they nearly were) parts. As a matter of fact, it took over three weeks to complete the work.

The largest shops in or around the city are either oil-well tool builders or structural iron concerns. It is with these that steady employment can be obtained, but if one never has made oil-well tools before, it takes some time to get acquainted with the work. One-sixty-fourth or one-thirty-second inch is amply close enough on this line of work, but nevertheless these are the shops to be employed in out here. The one with which the writer is employed gives its men (about 400) each a turkey at Christmas and a picnic in August. Smoking is permitted in the shop and visitors are allowed. There is a cordial feeling between the owner of the shop and the men, and there is a standing invitation to call on the general manager and talk over with him any dissatisfaction that may arise. It is gratifying to note that the carpet on the floor in the general manager's office is not worn threadbare on this account. The shop is equipped with the best class of machinery imported from the East. The planers stand up well under the heavy cuts taken, but the lathes, of the strongest make known to the writer, are not very satisfactory for oil-tool work, involving the rapid machining of nickel and other similar steels.

The railroad shops have not been mentioned because the the average toolmaker knows practically nothing of locomotive work. Therefore, the mechanic coming from the East must choose between three different branches of machine shop work, besides the railroad shops, *viz*: Garages and job shops, the structural iron works, and the oil-well tool shop. The last named branch includes shops for mining machinery, gas and donkey engines and oil-well supplies.

If a man gets a job in an oil-tool shop and has never worked in this kind of a shop before, it may bother him at first to swing the work on 45-degree centers and to put in the center-hole with a prick punch. Flat drills are used almost universally except in the drill press. The "joint-turner" is a specialist here and is paid $4.50 for nine hours. The average wage of a good mechanic is 40 cents per hour, but by going to the oil fields, a good oil-tool man can get $6.00 per day with house rent, gas and water free. Nevertheless, it is difficult to keep good men in the oil fields even at that price. Good machine blacksmiths on oil-tool work receive from $5.00 to $7.00 per day, tool dressers from $4.00 to $5.00, and helpers in the shop where the writer is employed get $2.50 for nine hours, with time-and-a-half for over-time and double time for Sundays and holidays.

Los Angeles is an open shop town and efforts to unionize it have thus far failed. The strike inaugurated more than a year ago has practically been unsuccessful, although there are men "out" who still have hopes. The railroad shops appear to be holding their own although it was alleged that there was a complete "walk-out" at the time of the beginning of the strike. Unless the railroad machinists, however, are aided by the engineers and trainmen, it would seem that the chances are against a complete victory for the strikers.

Besides the work here, however, we must consider the climate; although hardly any two seasons are alike, we have no severe weather changes. It is much more comfortable here than in the East, and the only snow we see is on the mountains. There are a great many places to go to for recreation, both on the mountains and at the seashore. The thermometer registers as low as 40 degrees F., and as high as 100 degrees. Los Angeles is no place for consumptives or for those having bronchial troubles. We have fogs at different times of the year, but they furnish moisture for our fruit growers and tone down the temperature of the hot days. There are a great many old people here who expect to, and do, live longer than in the East. The cost of living, in the writer's opinion, is as low as in the East.

* Address: 625 Esperanza St., Los Angeles, Cal.

* * *

GERMAN VIEW OF TRADE SECRETS

A remarkable decision relating to trade secrets was recently handed down by the highest German court. Several men who had been employed in a factory started a competing works and utilized, in the new undertaking, their knowledge of various decorative designs of the former employer. The latter brought suit on the basis of the German law against unfair competition and the lower courts decided in his favor, but the highest court reversed this decision and stated that the members of the new company acted within their lawful rights. According to the opinion of the court, trade secrets which are confided to an employe, or which become known to him in a legitimate manner in the course of his employment, may not be disclosed by him to outside parties while he remains in that employ; but the prohibition ends with the period of employ, and the acquired knowledge may be used thereafter in any way.

* * *

DECISION IN KRUPP PATENT SUIT

For several years the Krupp Co., of Germany, has been in litigation with the Midvale Steel Co., of Philadelphia over certain armor plate patents. Four suits were brought to restrain the Midvale Steel Co. from manufacturing armor plates, it being alleged that the processes used infringed the Krupp patents. The United States Circuit Court of Appeals handed down a decision October 11 dismissing the suits. The decision given by Judge Joseph Buffington stated that the evidence was not sufficiently satisfactory either in quality or amount to establish an infringement. It was declared by the court that two of the claims of the Krupp patents are invalid and that there could be no infringement of them even if the same process was employed by the defendant.

MAKING DIES FOR HAMMERING MACHINES

By CHESTER L. LUCAS*

Machine hammering, a process akin to swaging, plays an important part in the manufacturing processes in the jewelry and allied trades. A greater variety of work may be hammered than it is possible to swage, and for this reason the process is adapted to the forming of ornamental shapes, such

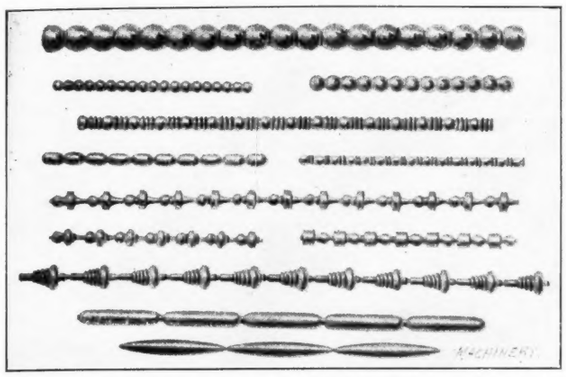


Fig. 1. Samples of Products of the Hammering Machine

as beaded work and jewelry parts, either from solid stock or tubing. The advantage of the process over screw machine production is threefold; less material is required for the work, the resulting product is stronger on account of the compression of the metal, and the surface of the stock is not removed, thus making it possible to work rolled gold-plated wire and tubing. The hammering machine is not a competitor of the screw machine, although many classes of work can be done better by the hammering machine.

Fig. 1 conveys an idea of the range of work that may be done on this machine. This illustration particularly shows the value of the hammering machine in the optical and kindred trades. The Langelier Mfg. Co., Providence, R. I., makes a great many dies for these machines, and as the die-making operations, as well as the hammering process itself, are a little out of the ordinary, a description of the work may be of interest.

The "Baby" Hammering Machine

Fig. 3 shows the smallest size of the Langelier hammering machines with the front plate removed to show the construction of the operating mechanism. This machine will operate on work of brass or composition wire up to ⅛ inch in diameter, and tubing, the walls of which are not over 0.024 inch thick, up to ¼ inch in diameter. The fact that tubing may be worked by this method makes it possible to manufacture hollow beads from gold-plated tubing.

In the illustration of the hammering machine, Fig. 3, the dies are shown at *A* and *B*, with a piece of work in process of being hammered into shape. The lower die *B* is adjustable in height, being raised or lowered by a foot lever that carries a pinion at its upper end, which in conjunction with rack *D* operates a cross-slide. As the top side of this slide is wedge-shaped, and the lower face of the anvil-block is also wedge-shaped, the anvil-block that carries the lower die may be raised or lowered at will by the foot lever.

While being hammered, the stock is held in a small chuck *F*, at the end of the rotating spindle *G*. This rotating spindle may be turned by the handwheel *H*. By throwing in the friction clutch, the spindle and work will be automatically rotated. The spindle is driven by a tongue extending throughout its length, but it may be moved laterally by hand when feeding the work. By means of trip *P*, attached to the anvil-

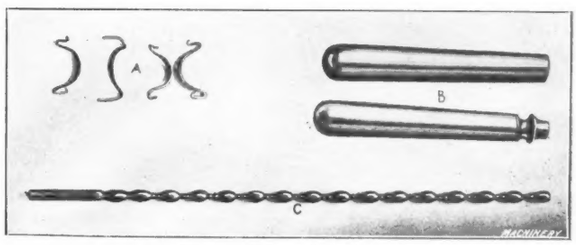


Fig. 2. A, Nose-pieces used in Optical Work; B, Hammered Knife Handle and Blank for Same; C, Hammered Work produced by the Machine shown in Fig. 8

block, the clutch is automatically thrown in as soon as the die is raised to the work. As soon as the die is lowered, trip *P* comes into contact with arm *Q*, throwing out the clutch and stopping the rotation of the spindle.

The force of the blow is regulated by a set-screw *O* at the top of the machine. The operating mechanism consists of six rollers *J* which actuate the slide *M* that carries the upper die. These rollers are carried in the roller cage *K* which is integral with the driving shaft. While the rollers are held in this roller cage, they project through its outer edge, so as to extend slightly beyond it. Then, as the shaft revolves, these rollers successively strike roller *L* which is similarly encaged in slide *M*. This slide is kept normally raised by a spring, not shown, so that it returns to its normal position after each downward

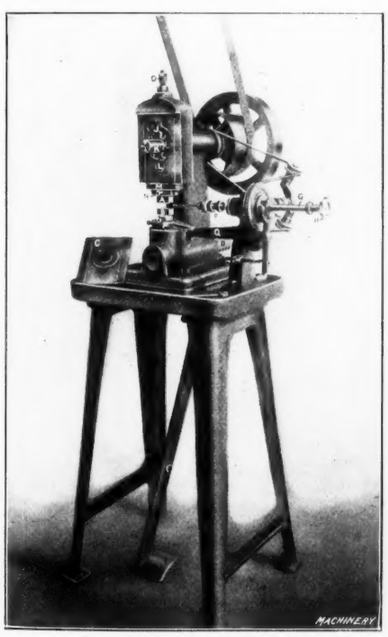


Fig. 3. Hammering Machine with Front Plate removed to show Operating Mechanism

Fig. 4. Finishing the Hob for Making Hammering Dies

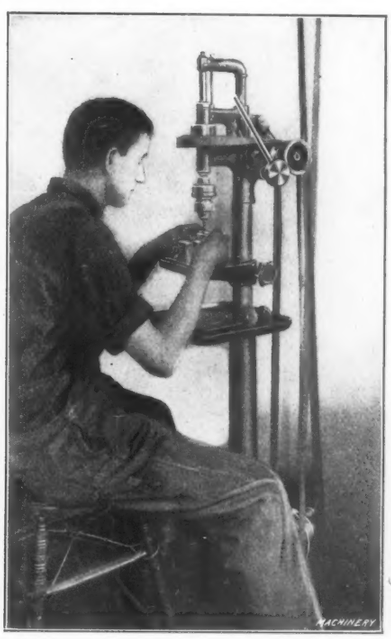


Fig. 5. Reaming the Impressions in the Dies by the Use of the Hob

* Associate Editor of MACHINERY.

impulse produced by the revolving rollers *J* striking against roller *L*. As six blows are struck during each revolution of the shaft, the action takes the form of a continuous vibration. On some classes of work, the upper die strikes 3600 blows per minute.

Making the Hob for a Die

The important factor in turning out a pair of dies for the hammering machine is the hob, or reamer, by means of which

Fig. 6. Chipping the Clearance in a Pair of Dies

the impressions are cut in the die blanks. Fig. 9 shows at *A* a number of hobs that have been made and used on past jobs. Needless to say, these hobs are very carefully kept, in case the dies should require renewal. In making a hob, the first step is to lay out and file a sheet metal templet, covering five or six units of the design, to shape. The hob is then roughed out in a lathe, using the templet as a guide. The die-maker interviewed, used the tool-holder and tools shown at *B* and *C*

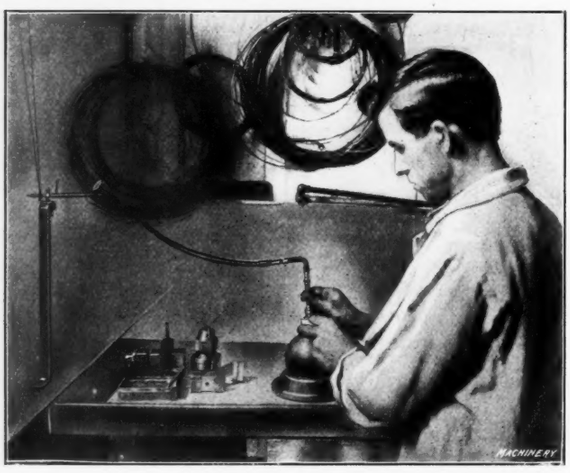


Fig. 7. Polishing a Die by means of a Flexible Shaft, Boxwood Tips and Carborundum

in Fig. 9 for this operation. After the hob has been roughed out, a forming tool like that shown at *D* is made to fit one section of the hob, and one section of the hob at a time is brought to shape.

The hob is cleaned up and finish filed in a speed lathe, as shown in Fig. 4. Hand tools are used exclusively in putting on the finishing touches, the die-maker trying the templet often to make sure that it fits correctly. As soon as one or two units of the hob have been finished, the stock is drawn farther out of the chuck and the new section worked upon. After the hob has been finished to fit the templet, it is ready for fluting. The fluting operation is a simple one, being done with a very acute-angled cutter like that shown at *E* in Fig. 9. The hobs are relieved by hand filing, hardened, and drawn to a straw color.

Reaming the Impressions in the Dies

The die blanks themselves are made of tool steel, turned up with shanks three-quarter inch in diameter. For most work, the faces of the dies used in this size of hammering machine are made one inch wide and two inches long. In Fig. 9, *F* shows the face view of a pair of dies, and *G* shows the end view. In cutting, or as it is called "reaming" the shape into the die blanks, the bulk of the steel is first removed from the blanks in a shaper. Not only does this facilitate the work of quickly removing the metal, but the shaped recess serves to guide the hob when starting to ream the dies. The clamp shown on the bench in Fig. 7 is employed for holding the dies while being reamed. The hob is held in a drill press, in the same manner as a reamer, and the dies are held in contact with it by the special clamp in the manner illustrated in Fig. 5. At first the dies are but lightly clamped against the hob or reamer so that they will not catch. Gradually the dies are clamped tighter upon the hob, until finally the faces of the dies

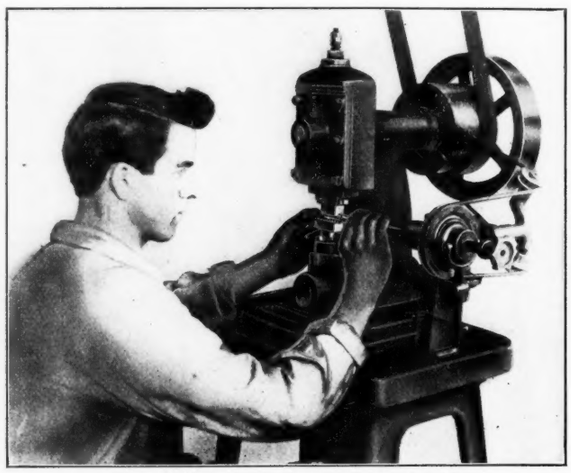


Fig. 8. Method of using the Hammering Machine

meet, thus indicating that the hob has been sunk to its full depth. The impressions must be cleaned out occasionally during the reaming, and plenty of good lard oil must be applied to obtain smooth surfaces.

Finishing the Dies

Fig. 6 illustrates the die-maker chipping the clearance at the edges of a die impression. The edges of the impressions are

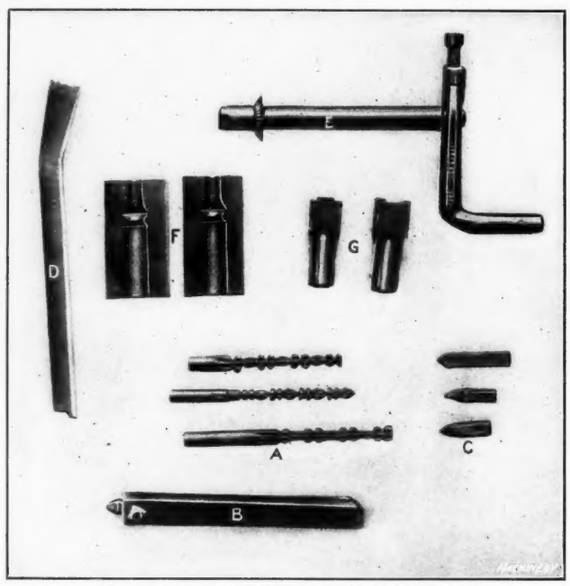


Fig. 9. A Few of the Special Tools, Hobs and Dies

very sharp, and of perfect form after reaming, but in this condition they would mar the surface of the stock being hammered. After the edges have been slightly chamfered by chipping, they are smoothed up with file and emery cloth; then the dies are ready for hardening. The die on which the work-

man is chipping the clearance in Fig. 6 is one of the pair shown at *F* in Fig. 9, and the work that these dies do is well illustrated at *B* in Fig. 2. The upper piece is the steel blank for a hollow knife handle, and the lower piece shows how it appears after the hammering operation. From the photograph it will be seen that the hammering has increased the length perceptibly. The making of the hollow handle blank itself is an interesting operation—but that is another story.

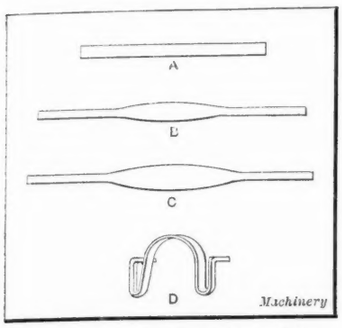


Fig. 10. Eye-glass Nose-piece and its Development

Not the least interesting part of the die-making is the polishing operation that follows the hardening. The dies must be well polished before being put into use, and this is accomplished by the use of a flexible shaft that terminates in a small chuck, as shown in Fig. 7. The die is held in a ball-vise, and is polished with boxwood sticks that are held and revolved by the chuck. Fine carborundum and oil are applied, so that the boxwood points really become laps. Power is supplied by a string belt from an overhead shaft.

In making dies for work that is to be separated, like small ornaments or beads, the dies are left with a cut-off at one end, so that as the work is moved forward in the dies, one section will be completed and cut off at each forward movement of the stock. In all hammering dies, each succeeding pair of units of the design is slightly smaller than the previous pair nearer the end where the stock enters, so that each set of sections of the dies closes the metal down a little more until it is finished by the last set. In changing the position of the work, the foot lever is released, allowing the lower die to drop enough to shift the tube or rod forward one section.

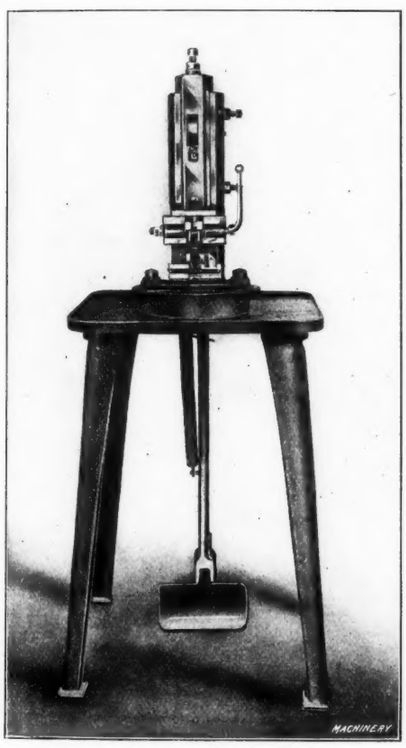


Fig. 11. Nose-piece Bending Machine

Fig. 8 shows the die-maker trying-out a set of dies for the piece shown at *C* in Fig. 2. This is a good illustration of the method of holding the work and the operation of the hammering machine.

Nose-piece Bending Machine

Although a little apart from the subject of this article, it may be well worth mentioning an extremely interesting piece of wire forming which Mr. J. B. Palizza, engineer for the Langelier Mfg. Co., showed the writer. The work consisted of nose-pieces used in manufacturing eye-glasses. Some of the different styles of these nose-pieces are illustrated at *A* in Fig. 2. The wire from which these are usually made is gold-filled, and a great deal of it is made in the manner described in an article entitled "The Making of Seamless Gold Wire," published in MACHINERY, March, 1911, engineering edition.

The wire is first cut to length as shown at *A*, Fig. 10, after which each end is swaged down as shown at *B* in the same illustration. The saving in stock effected by the use of the swaging operation is very apparent, and as has been mentioned before, the swaging operation does not injure the gold covering of the work. The blanks are now annealed so as to make them soft enough for the two succeeding operations. The third step, shown at *C*, Fig. 10, consists in flattening the swaged blank throughout its length, and the result of the final operation of bending the nose-piece to shape is shown at *D*.

Fig. 11 shows the machine used for bending the nose-piece to shape. By its use, various shapes and sizes of nose-pieces may be bent by substituting different formers in the dies. The dies themselves, as well as the foot press in which they are used, are the work of the Langelier Mfg. Co.

The construction and operation of the machine may be followed by referring to the view in Fig. 12. The lower half of the dies consists of a bolster *A*, bolted to the bed of the press. Upon this bolster, the two halves of the lower die are mounted on slides *C*, and kept normally together by spiral spring *D*; *E* is an adjustable gage used for locating the blanks in the dies. At *F* is shown the shoe that holds the blank firmly in place until the main former *G* comes down to make the principal bend. The lower die sections support the wire, while the upper die sections *H* are bending the ends, and former *G* is bending the nose section. Hand lever *I* operates shaft *J*, which carries the two punches *L*, the function of which it is to offset the ends of the nose-piece.

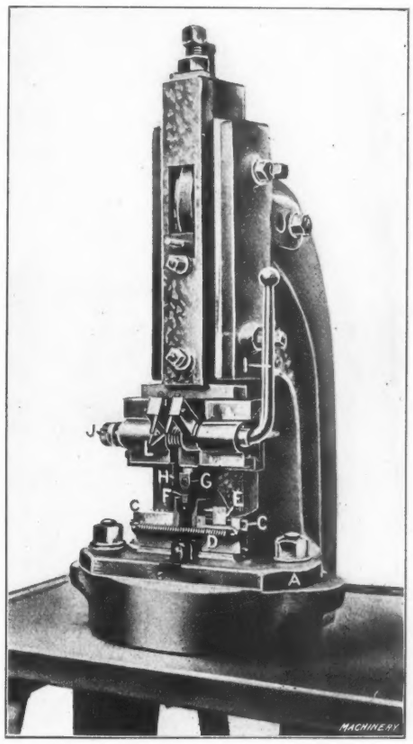


Fig. 12. Mechanism of Nose-piece Bending Machine

In operation, the blank is laid across the lower die sections and against gage *E*. Foot pressure upon the treadle brings down the ram of the press, causing the upper die sections *H* to bend down the outside ends, while former *G* is making the main bend. At the end of the stroke, pressure is still retained upon the treadle while the operator brings forward lever *I* to offset the ends of the nose-piece by means of punches *L*, as mentioned. The whole bending operation requires but a few seconds, and is easily carried out by an unskilled operator.

Credit is due to Mr. A. T. Langelier, treasurer of the Langelier Mfg. Co., and Mr. A. J. Langelier, manager of the factory and designer of the machines illustrated, for courtesy shown the writer in the preparation of this article.

* * *

Paint which indicates changes of temperature by a change in color can be made, according to the *Mechanical World*, by a mixture of 7 parts of saturated solution of potassium iodide and 134 parts of saturated solution of mercuric chloride with 1 part of pulverized copper sulphate and the necessary oils and driers. The paint changes its color between 115 and 130 degrees F., and can be applied to any surface of which it is desirable to determine the temperature. The range of temperature at which the color-changes take place may be slightly varied by altering the proportions of the ingredients.

RE-CUTTING MILLING CUTTERS WITHOUT ANNEALING

By F. B. JACOBS*

In everyday shop practice it is customary to sharpen ordinary milling cutters on the periphery only. There are two reasons for this: One is that the side teeth seldom become dull after they have been backed off, and the other that it is often impractical to re-sharpen the side teeth as a given size has to be maintained. The result is that as soon as the peripheral teeth have been nearly ground away by repeated sharpenings, the cutter finds its way to the "tool steel scrap," to be sold for a very small percentage of its actual value. Experience teaches us that to anneal and re-cut milling cutters in the regular way is not practical, although it is sometimes done, to keep a toolmaker busy or to give the apprentice boy experience. It is not practical because the size of the hole is always "lost" in annealing, and generally twenty-five per cent of the cutters are lost in rehardening, owing to fire cracks.

It is common practice in some shops to re-cut small or thin cutters, milling saws for instance, by hand. The method generally employed is to lay them on a wide rest and feed the teeth, one after another, toward the center of a grinding wheel, the face of which is trued to the proper angle. This method is not practical on large or wide cutters as the circumference of the wheel leaves the teeth hollow, and the accurate spacing of the teeth is invariably lost. Again, the ordinary wheel, as used for cutter sharpening, will not hold its shape long enough to do more than three or four teeth

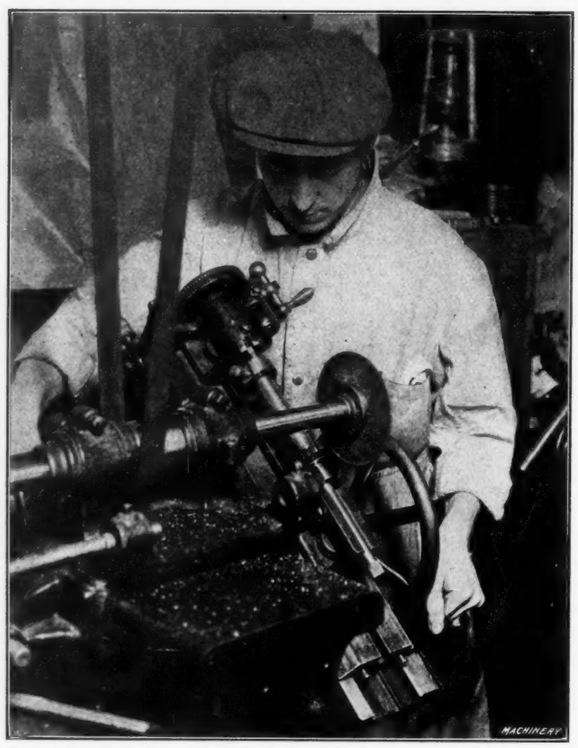


Fig. 1. Re-cutting Milling Cutters in Brown & Sharpe No. 3 Cutter Grinder

without re-dressing, which of course wears away the wheel very rapidly.

However, if the following practical method is employed, no machinist will experience any difficulty in reclaiming many cutters that are now peacefully reposing in the scrap box, awaiting the call of the junk man. An ordinary automatic surface grinder can be used, provided it is equipped with dividing centers. As the writer's experiments in this line were conducted with a No. 3 Brown and Sharpe cutter grinder equipped with a form-cutter grinding attachment, the method used in that case will be described.

The cutter, shown in Fig. 2, was held on an arbor between the centers of the cutter grinder, as shown in Fig. 1, and the teeth were gashed out one after another. (See Fig. 3.) For this purpose, an aloxite vulcanite wheel 7 inches in diameter, ⅛-inch face, 1¼-inch hole, 39 grit, V-K-9 bond was used. This wheel was run at a speed of 4370 R. P. M. A higher speed would be practicable, as a vulcanite wheel must be run at a very high speed to show high efficiency. Contrary to the general rule, wheels with vulcanite bond do not burn the work when run at high speeds. With the cutters in question, the gashing was made ⅛ inch deep. One tooth was done at a time, with three cuts, one after another, so that each cut was approximately 0.042 inch deep. With

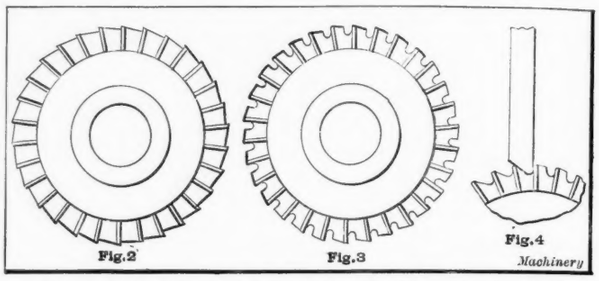


Fig. 2. Cutter to be re-cut

Fig. 3. Cutter after First Grinding Cut

Fig. 4. Effect of Final Grinding Cut

this cut no evidence of burning was noticeable. The direction of the wheel and feed should be the same, or in other words, the same as a gear and rack run together. When fed in the opposite direction, which on first thought appeared to be the more practical way, it was found that the wheel had a tendency to burn, in breaking through. After the first tooth was gashed to the required depth, the graduations on the cross-slide screw were relied on to determine the proper depth for the remainder of the teeth. On each tooth, the cutter was set to bring what was left of the original face to within a few thousandths of the wheel. The old teeth were relied on wholly for the proper spacing. The object of this gashing was to preserve the corner of the wheel used for the second operation, which consisted of grinding away the superfluous stock between the bottom of the gashes and the points of the teeth.

In this operation, the cutter was held as before and the teeth were ground out one at a time by being fed under a wheel having its face trued to the proper angle. (See Fig 4.) An aloxite wheel 5 inches in diameter, ⅜-inch face, 1¼-inch hole, 50 grit, 0 grade, D496 bond was used, the speed being 3500 R. P. M. The wheel was set central, and in re-cutting, the face of each tooth was brought to within a few thousandths inch of the back or flat side of the wheel. The cutter was then fed back and forth under the wheel taking a chip of approximately 0.002 inch at a time, until the land of the tooth was of the proper dimension, or about 1/32 inch wide. The cutter was then turned just enough to bring what was left of the original face of the tooth to bear on the back side of the wheel. This removed the small amount of stock not taken out by the first operation, and matched up the side and face teeth.

It is somewhat difficult to give exact figures regarding the time it should take to re-cut cutters of different dimensions, as the human element has to be taken into consideration. The writer's time for gashing, re-cutting and backing off two "Novo" steel cutters 3 5/16 inch in diameter, 1/2-inch face, having thirty teeth, was two and one-half hours. As this work was wholly of an experimental nature it is reasonable to assume that any machinist could, with a little practice, do the same work in much shorter time. For an illustration, assume that a machinist of ordinary ability, at 30 cents per hour, takes two and one-half hours to re-cut the cutters mentioned. Two and one-half hours at 30 cents per hour equals seventy-five cents. As the cutters in question, when re-cut, are practically as good as new, it does not take an expert on production costs to see that it is worth while to reclaim the worn-out cutters by the method described.

* * *

The factory full of contented men when cold weather comes is the one properly equipped with heating apparatus which is kept in good order and working.—*The Wood-worker.*

* Address: Care of The Carborundum Co., Niagara Falls, N. Y.

THE ROSS RIFLE AND ITS MANUFACTURE—3

THE PROCESSES EMPLOYED IN THE MANUFACTURE OF A MILITARY RIFLE OF UNIQUE DESIGN

By DOUGLAS T. HAMILTON*

While extremely simple in operation, the Ross rifle is far from being an easy manufacturing proposition. It requires about 1142 separate and distinct operations to make the complete rifle. The receiver, bolt sleeve and bolt are the most difficult parts to produce, with the exception of the barrel, as far as the machining operations are concerned, and it is the manufacture of these and other minor parts, which will be dealt with in the following article.

The receiver, shown in Fig. 29, requires some forty different operations, and is one of the most important parts of the Ross rifle. After being drop-forged, the front and rear ends are drilled in an upright drill press of special design, shown in Fig. 34. The front end *A* is then recessed and faced in a hand screw machine, after which the bottom face *B*, terminating at the point *C*, is milled in a Lincoln milling machine, using a straight milling cutter; this operation is completed in one pass of the cutter.

The receiver is next taken to the Lincoln milling machine, shown in Fig. 30, where the circular cut *D* on the front end is made. This operation is performed more quickly and the

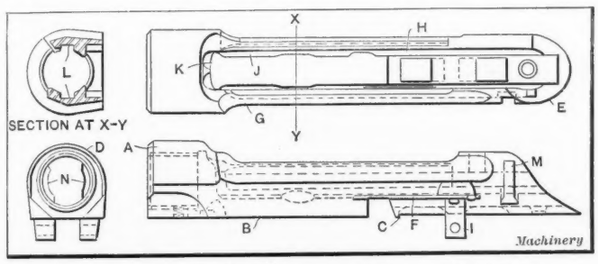


Fig. 29. Plan, Elevation and Sectional Views of the Receiver

work is given a better finish in the Lincoln miller than would be possible in the lathe. The receiver *A* is held on two plugs fitting in the drilled holes in each end and is clamped to a revolving fixture which is rotated through 180 degrees by means of a worm and worm-wheel enclosed in the cast-iron box *B*. The worm is driven by a bevel gear *E*, which is operated from the rear of the machine through spur gearing. The worm-wheel is directly connected to the work-holder *F*, and the rotation of the latter is stopped at the desired point by the indexing holes in the worm coming in contact with a

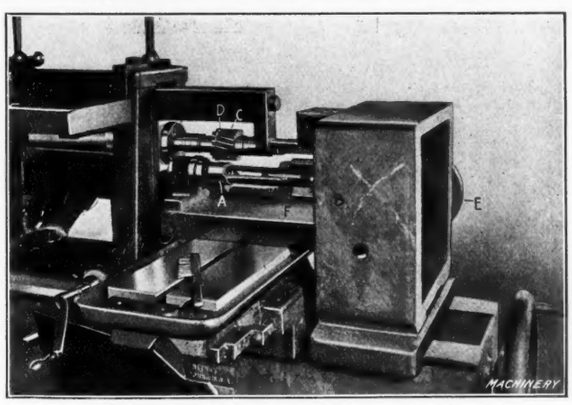


Fig. 30. Milling Circular Portion of the Receiver in a Lincoln Miller

finger, which throws out the feed. The cutter *C* finishes the circular part, and the cutter *D* chamfers the end.

The circular part *E* on the rear end of the receiver (see Fig. 29) is then finished in the Lincoln milling machine in a similar manner to that just described for the front end. A saw slot *F* for the cut-off which ejects the empty shell is next cut in the Lincoln miller, after which the left- and right-side top angles *G* and *H* are profiled in a Pratt & Whitney machine. During these operations the receiver is held on studs fitting in both ends, which are used for locating it during all the subsequent operations. The opening between the lugs *I* is now profiled, after which the top angle *J* on the right side is finished. The inside face of the receiver is next profiled for the bolt sleeve clearance, and the opening for the magazine is made. The part around the ejector slot is

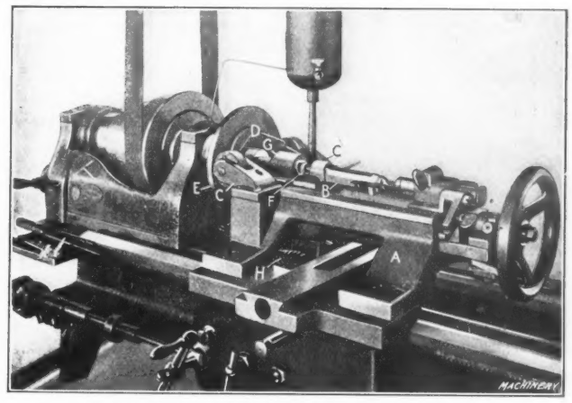


Fig. 31. Cutting the Cam-faced Lugs in the Receiver

then profiled, after which the cartridge opening *K* is finished in a similar manner.

The next operation is to cut the guide slots *L* in the receiver for the tongues on the bolt sleeve. The slot *M* for the bolt stop is then cut in two operations. In the first operation the straight slot is cut, and in the second operation the T-shaped portion at the bottom is cut, forming a seat for the bolt stop.

Cutting the Cam-faced Lugs in the Receiver

The receiver is now ready to have the cam-faced lugs cut, behind which the lugs on the bolt are locked. This is done

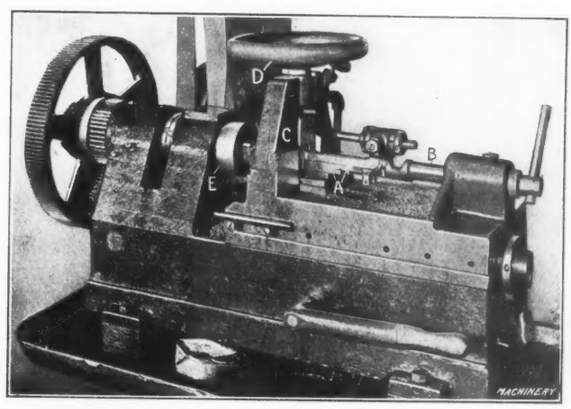


Fig. 32. Tapping the Threads in the Receiver, used in fastening it to the Barrel

in a lathe especially fitted up for this purpose, which is shown in Fig. 31. A cast-iron fixture *A* straddles the ways and is fastened to the carriage. This forms a base on which there is a slide, carrying a fixture provided with a center and clamping device, which holds the receiver *B*. Two brackets *C* attached to the base *A* are furnished with rollers *D*, which rotate on a face cam *E*, the latter being screwed onto the nose of the spindle in a similar manner to an ordinary faceplate. An arbor *F*, fitting in the nose of the spindle and supported in the bracket *G*, carries a small cutter (not shown) which is used for cutting these cam-faced lugs. The 3-inch rollers *D* are held in contact with the face cam *E* by coil springs *H*.

In operation, the face cam *E* transmits a reciprocating motion through the rollers *D* to the carriage, which is disconnected from the regular feed-screw, thus allowing it to be moved back and forth. Cam *E* is only provided with one projection, which comes in contact with first one and then the other roller, thus taking a cut off both cam-faced lugs for each revolution of the spindle. The feeding of the work to the cutter is accomplished by the back-and-forth movement of the carriage holding the work, which, through a cam and roller, operates a finger, the latter rotating a ratchet disk connected to the feed-screw attached to the top slide.

* Associate Editor of MACHINERY.

Cutting the Thread in the Receiver

The front end *A* of the receiver, Fig. 29, is furnished with a buttress thread of 1/20 pitch, by means of which it is attached to the barrel. This thread is first roughed out by a small cutter of the desired shape. The machine in which it is accomplished consists essentially of a head, provided with a thread of the correct pitch and furnished with a

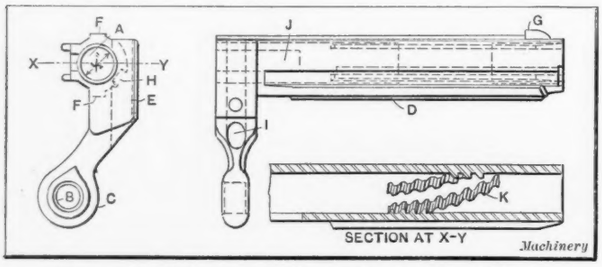


Fig. 33. The Bolt Sleeve—Section showing the Threaded Ribs

clamping member in which the receiver is held. The forward travel of the work is guided by this master thread, and the internal cutter cuts the thread. The cutter is started in a certain relation to the receiver, so that it will match up properly when assembled on the barrel.

The thread is only roughed out in this operation, and is finished with a tap. The receiver *A* is held on the rear center *B* of the machine shown in Fig. 32, and is clamped in a fixture in the head *C* by means of the handwheel *D*. A tap held in the head *E* has a slot cut in it acting as a locating point. The carriage carrying the receiver is fed forward by a lead-screw having the same pitch as the tap. The machine is driven by friction pulleys at the rear through the gearing as shown, and the spindle is reversed by shifting the belt from one pulley to the other.

Three holes are now drilled in the front end of the receiver, two of which are tapped out for the screws that hold the trigger guard, while the third hole is tapped out to fit a screw acting as a cam for starting the rotation of the bolt. After this the bolt sleeve clearance is profiled, and the name rolled in the side, when the receiver is ready for polishing and hardening in oil.

Machining Operations on the Bolt Sleeve

The bolt sleeve shown in Fig. 33 is made from a drop-forging, for which two dies are used, one for breaking down and the other for finishing. The drop-forging is milled to length, after which the hole *A* is drilled in the upright drilling machine shown in Fig. 34. The bolt sleeve *A* is held in a jig *B* in the revolving head of the machine, and when it has been set, the cover *C*, shown thrown back, is closed, thus preventing the oil from flying around. The hole is drilled with a C-drill *D*, which is of the same type as that used for drilling the hole in the barrel. This drill is not revolved; it is held in the head *E*, which is fed up automatically by the feed-screw *F*, the head being returned to the "down" position when the hole is completed by means of a trip, which, through gearing, reverses the direction of rotation of the feed-screw.

The ends of the sleeve are now faced in a lathe, after which the hole *B* (see Fig. 33) is drilled and counterbored. This hole *B* and the hole through the receiver are used as locating points in the subsequent operations. The handle *C* is then circular milled in a milling machine, the bottom face *D* is milled in a Lincoln miller, the top face *E* is finished, and the sides of the ribs *F* are milled, after which the under side is finished. The back face of the lug *G* is then milled and the sides of the ribs are profiled.

The next operation is to place the sleeve in a profiling machine and profile the extractor slot *H*. This requires three cuts; the square part of the slot is milled with a circular cutter and a T-shaped cutter mills out the beveled sides which retain the shell extractor. The top of the sleeve is milled with a circular form cutter in the milling machine and the hole *I* for the bolt lock is drilled in a jig. The hole *A* is ½ inch in diameter, which is the root diameter of the thread in the bolt sleeve. The bolt sleeve is now counterbored on each end to the outside diameter of the thread in an upright drilling machine, after which it is reamed on both ends. The slot *J* for the cocking piece is then milled, leaving the bolt sleeve ready to have the spiral grooves cut.

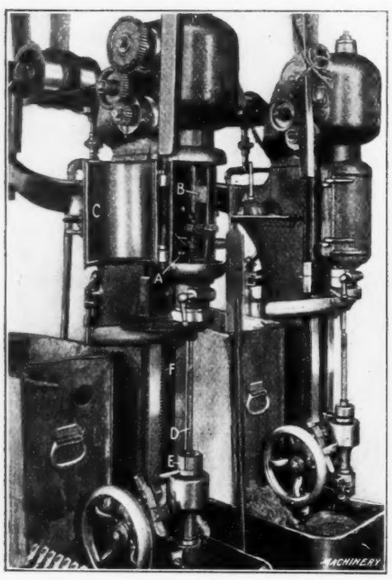


Fig. 34. Drilling the 1/2-inch Hole in the Bolt Sleeve

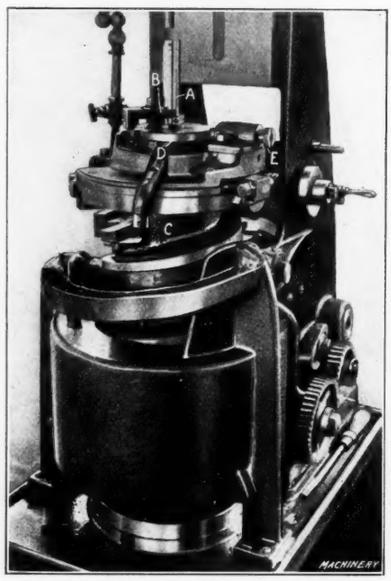


Fig. 35. Cutting the Spiral Grooves in the Bolt Sleeve

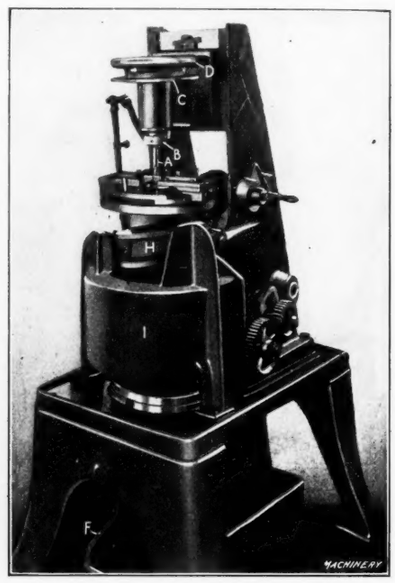


Fig. 36. Cutting the Spiral Ribs on the "Straight-pull" Bolt

Cutting the Spiral Grooves in the Bolt Sleeve

The spiral grooves having a pitch of 4.86 inches are cut in the machine shown in Fig. 35, where the bolt sleeve *A* is held by a clamp *B* to the top face of the "spiral" head. A bar, similar in shape to a boring-bar, is inserted in the sleeve, and is provided with a small cutter. This bar is held to the spiral head *C*, which is provided with a master screw of the same pitch as the grooves to be cut in the bolt sleeve. That

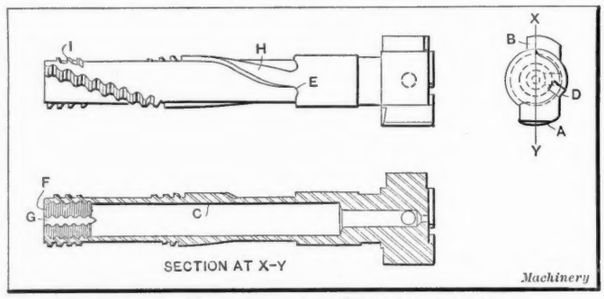


Fig. 37. Three Views of the "Straight-pull" Bolt

part of the machine holding the sleeve remains stationary, the head *C* alone rotating and thus traveling up and down, while the tool cuts the spiral grooves. The cutter is fed in to the required depth automatically by a feeding arrangement similar to that used on the profiling machine, while the indexing is accomplished by hand. The plate *D* is provided with four notches in which a spring plunger *E* fits. As soon as one groove is cut to the required depth, this spring plunger is drawn back and the head is indexed.

The buttress thread *K*, Fig. 33, is now cut in the bolt sleeve; this operation is performed with a tap in a machine similar to that shown in Fig. 32. The grooves cut in the machine, Fig. 35, were only 3/16 inch wide and have to be increased in width, so the bolt sleeve is taken to another machine, similar to that shown in Fig. 35 but equipped with a wider cutter. This operation is called "shaving between the false working spirals." The bolt sleeve is now finished, except for carbonizing, polishing, hardening and inspecting.

Machining Operations on the Bolt

The bolt, shown in Fig. 37, is made from tool steel in an Acme automatic screw machine. The sides of the lugs *A* and *B* are straddle-milled in a Lincoln milling machine, after which the hole *C* is drilled in the barrel drilling machine shown in Fig. 18 in the November installment. This hole is then reamed to 0.375 inch, the ejector slot *D* is profiled, and the "vent" holes *E* for the starting of the spirals are drilled. The buttress thread *F* for the firing pin and spring retainer is then tapped in a hand screw machine, and the slot *G* broached in a punch press.

Forming the Spiral Ribs on the Bolt

The grooves forming the long spirals *H* and the short spirals *I* are cut in the spiraling machine, Fig. 36, after

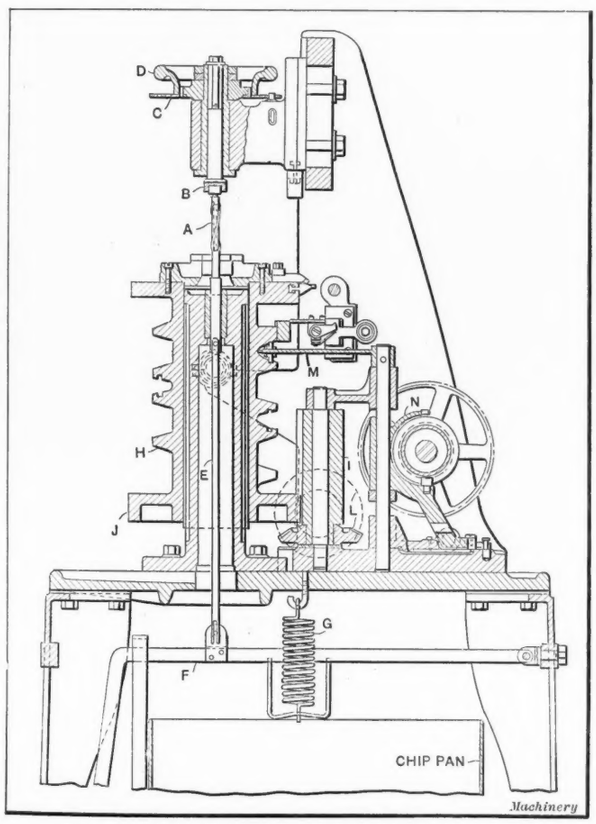


Fig. 38. Sectional View of Spiraling Machine used in Cutting Spiral Ribs on the Bolt

which two of the ribs are partly removed in a machine of a similar type, leaving the short spirals as shown in Fig. 37. The construction of the machine shown in Fig. 36 is similar to that shown in Fig. 35 as far as the working of the spiral head is concerned, but the work is held in a different manner and is operated upon differently. In the machine shown in Fig. 35, the bolt sleeve is rotated around the cutter, while in the machine shown in Fig. 36 the cutters are rotated around the bolt, the latter remaining stationary in the chuck *B*.

While the two illustrations Figs. 35 and 36 give a fair idea of the construction of these spiraling machines, a better understanding of their operation can be obtained by referring to the illustration Fig. 38, which is a sectional view of the machine shown in Fig. 36. The bolt *A* is here shown in position in the chuck *B*, but the four cutters are not shown. When this machine was first designed, the cutter head contained only one cutter, so that it was necessary to index the work for each groove, the plate *C* and handwheel *D* being

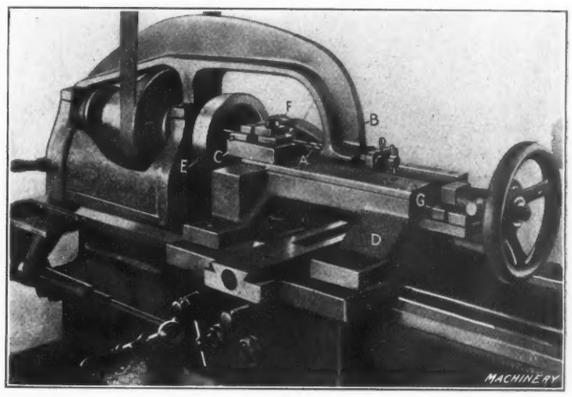


Fig. 39. Cutting Cam-faced Lugs on the Bolt

used for this purpose. Lately this machine has been redesigned and has been fitted with four cutters, which eliminates the necessity of indexing the work. The chuck *B* is cut out to fit the lugs on the bolt *A*, preventing the latter from turning. The bolt is held up in the chuck by a rod *E*, fitting in the hole in the forward end, and is forced upward by means of the lever *F*, which is shown protruding from the machine in Fig. 36, and spiral spring *G*. The work is removed from the chuck by simply depressing the lever *F*.

The driving power for the master worm *H*, which has the same pitch as that required on the bolt—4.86 inches—is obtained through a belt from the overhead works and is transmitted through spur and bevel gearing to the pinion *I* which meshes with the spur gear *J* cast integral with the master worm. The pinion *I* is driven by bevel gears *L* and is reversed to move the head up and down by means of a link *M* operating in the master worm and connected to a clutch *N*, which is disengaged from one train of gears to move the master worm up, and engaged with another train rotating in the opposite direction to bring it down. The worm is guided by lugs cast integral with the outer casing *I* of the base, Fig 36.

Shaving the Extractor and Locking Cams on the Bolt

The two lugs *A* and *B*, Fig. 37, are provided with cam faces, which lock behind corresponding cam-faced lugs in the receiver. These lugs are faced in a lathe provided with a special attachment, as shown in Fig. 39. The bolt *A* is held rigidly on centers, one of which is in the head, and the other in the arm *B*, while a cutter, held on the slide *C*, faces the rear faces of the lugs. The fixture *D* straddles the ways and is fastened to the lathe carriage, the latter being disconnected from the feed-screw. A face cam *E*, screwed onto the nose of the machine spindle, gives a reciprocating motion through a roller *F* to the carriage. The top slide *G*, carrying the cutter, is fed in by a ratchet device somewhat similar in design to that shown on the machine in Fig. 31. The front cam face on the lug *B* is cut in a similar machine.

The buttress thread on the spiral ribs *H* and *I* is cut in a machine somewhat similar in design to that used for cutting the thread on the breech end of the barrel. The space between the spiral ribs is relieved in a spiral machine of the type shown in Fig. 36. After a few minor operations, such as profiling the extractor slot *D*, the bolt is fitted to the receiver gage, hardened in oil, and ground in a Brown & Sharpe grinding machine. The lug *B* is ground slightly eccentric on its periphery and acts as a cam. After grinding, the bolt is inspected.

Practically all of the principal operations on the Ross rifle

have now been described in detail, but mention might be made of a few additional operations which incorporate certain interesting features. A number of the parts are made from machine and tool steel and are drop-forged. A representative group of drop-forging and trimming dies is shown in Fig. 40. Here *A* and *B* are the roughing and finishing drop-forging dies for the trigger guard; *C*, the dies for the trigger; *D*, the dies for the pawl; *E* and *F*, roughing and finishing dies for the bayonet; *G*, dies for the butt-plate; and *H*, the trimming punch and die for the butt-plate.

As a large number of the parts are made from drop-forgings, they require finishing, and as most of the work is circular milling or milling of irregular form, the majority of the

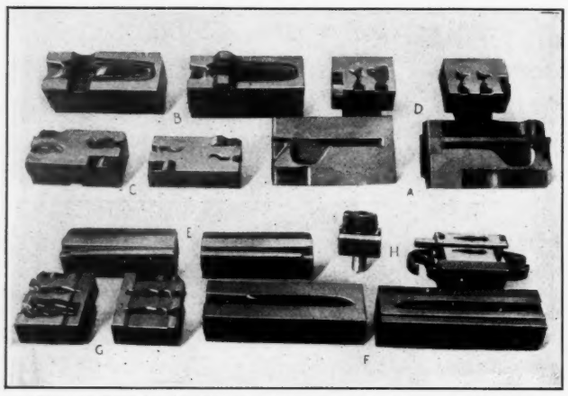


Fig. 40. Drop-forging Dies for Trigger Guard, Trigger, Butt Plate, and Bayonet

parts are machined in the profiler. An example of profiling is shown in Fig. 41, which shows the profiling of the rounded portion on the trigger guard. Most mechanics are familiar with the operation of the profiler, and it therefore needs no description.

Fig. 42 shows the stages in the various operations on the front and rear bands for holding the stock to the barrel, the butt-plate (which is placed on the end of the wooden stock), the trigger guard, trigger, sear, pawl, etc. The samples shown on these boards give a fair idea of the number of operations required on each of the parts. The bands are drawn up from sheet steel, in the powerful geared press shown in Fig. 43. One cupping and five redrawing operations, with annealing in between, are necessary to complete the drawing of these

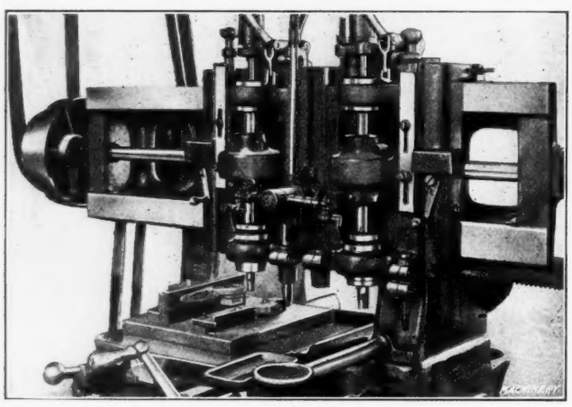


Fig. 41. Profiling the Trigger Guard

bands. This punch press, as well as the other punch presses throughout the works, is supplied with a C. J. Root counter, shown at *A*, which counts the number of pieces drawn through the press.

Aligning the Front and Rear Sight Bases

After the barrel has been inspected and the sight bases have been finished, it is taken to the assembling department where the rear and front sight bases are assembled. The rear sight base is put in a block jig *B*, as shown in Fig. 44, and this is slipped over the barrel *A* and placed in the fixture. The receiver has been assembled to the barrel, so that the latter is held in position by a clamp *C*, holding down the receiver. The sight base is held in the correct position by a wedge, and is forced onto the barrel to the desired distance by means of the lever *D*. The hole for the pin is then drilled, and the dowel fastening the sight base to the barrel is put in before the latter is removed from the fixture.

The base for the fore sight is now put in a jig *E* which is placed up against a stop on the fixture. Here the jig is so clamped as to hold the sight base in alignment with the rear sight base, and the sight base is pressed back to the point where it is to be fastened. The barrel is now removed from this fixture, a cross hole through the front sight band is drilled, and a pin is driven in.

Setting the Sight and Testing the Accuracy of the Military Rifle

Upon the completion and assembling of all the parts of the 0.303 Ross military rifle, it is taken to the government inspection department where the sights are set and the accuracy of the rifle is tested. The rifle is held in a mechanical rest, as shown in Fig. 45, which is so designed that the rifle will be held approximately in the same manner as when fired under ordinary conditions—in the hands of a soldier—as regards points of support, recoil, etc. The rifle *A* is elevated by means of the handwheel *B*, and is shifted laterally by means of the handwheel *C*. The fore part of the stock is supported against rollers to facilitate the lateral movement of the butt end. A target, similar to that shown at *D*, is placed 100 feet away from the muzzle of the rifle. The white space *E* or the target outline forms a rectangle 1 inch wide by 1½ inch high. Of course this target is placed in an enclosed shed, so that the wind cannot affect the flight of the bullet.

In testing the rifle, trial shots are fired to ascertain if the fore sight is in the correct position. After the inspector

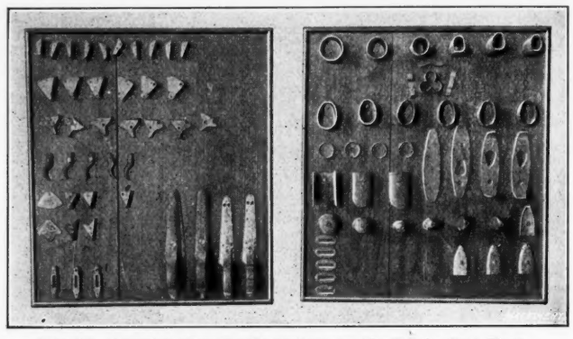


Fig. 42. Samples showing Operations on the Bands, Butt Plate, Trigger Guard, Trigger, etc.

has set the fore sight directly in the center of the rectangle *E*, by operating the handwheels *B* and *C*, and has discharged the cartridge, he looks through the telescope *F* to see where the bullet has hit. If he should find that the shot has gone ½ inch to the left, or is centering on the boundary line of the target, Fig. 45, he shifts the rifle laterally by means of the handwheel *C*, so that the sight is located ½ inch to the right of the center of the 1½- by 1-inch rectangle (Fig. 45). He now adjusts the fore sight laterally on the barrel so that it will be in line with the center of the rectangle or target. When the fore sight has been set and the rifle elevated to the proper distance, five shots are fired in rapid succession. All these shots must hit within the 1-by 1½-inch rectangle, and if they fail to do so the rifle is not accepted. The accuracy of this rifle is worth mentioning. While the writer was getting the information for this article, five shots were fired in rapid succession and each bullet practically passed through the same hole.

Before the rifles are put in the store, ten per cent of the number called for on the order are taken to another testing shed, where they are held in a mechanical rest, as before described, and are sighted at a target placed at a distance of 600 yards. Ten shots are fired at this target, and nine out of the group must lie within a two-foot circle or else the rifle is not accepted.

Obtaining the Muzzle Velocity and Maximum Pressure

To determine the muzzle velocity and the pressure developed by the explosion of a cartridge in the chamber of a rifle, a barrel *A* is screwed into a bushing held in the fixture *B*, shown in Fig. 46, by a knurled nut *C*. A telescopic sight

D is located in U-shaped supports, which are held in blocks *E* fastened on the barrel by wing nuts; this sight is used to locate the barrel in the proper relation to the target, which is placed at a distance of 180 feet from the muzzle of the barrel. The type of target used is shown at *G* and consists of two sheets of paper pasted together, a copper wire being first placed between the sheets, stretched back and forth and connected to two terminals.

When the rifle has been sighted, the cartridge is dipped up to the neck in Rangoon oil, and placed in the chamber of the barrel. A block *F* holding a cup in which is inserted

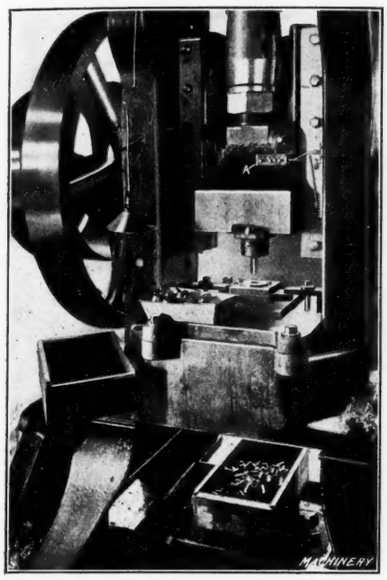


Fig. 43. Drawing the Bands in a Heavy Geared Drawing Press

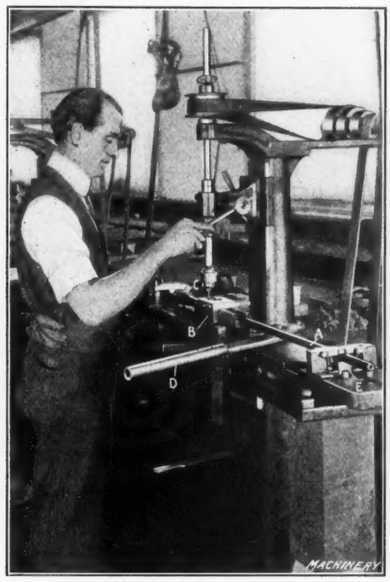


Fig. 44. Aligning and Assembling the Front and Rear Sight Bases

Fig. 45. Setting the Sights and Testing the Accuracy of the Military Rifle

a copper disk or "pressure block," as it is called, is then put in place, after which the block *F* is placed in the fixture, being held up tightly against the breech end of the barrel by a flat wedge not shown. The cartridge is discharged by a firing pin passing through the block *F* and the copper block, and is operated by turning the striker *H*, which is forced forward by a spring. As the striker is turned, a pin driven into it is brought in line with a hole in the nut *I*, allowing the spring to operate the striker carrying the firing pin.

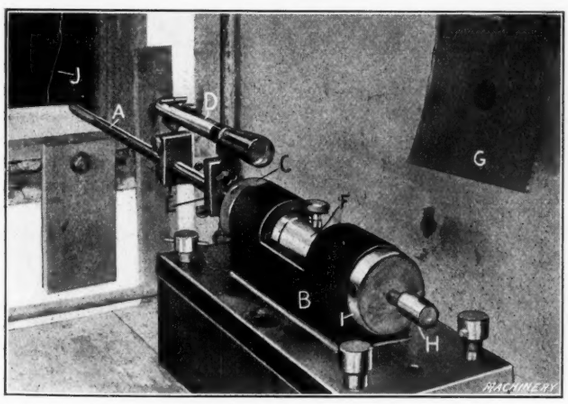


Fig. 46. Obtaining Muzzle Velocity and Breech Pressure

Upon the discharge and recoil of the cartridge, the copper block is compressed. As this copper block is measured before being inserted, and as the pressure required to compress it a certain amount is known, it is an easy matter to measure the block again and determine the maximum pressure in pounds per square inch.

The muzzle velocity of the bullet, more properly termed the "initial velocity," is obtained by means of an instrument called a "chronograph," which is shown in Fig. 47. The chronograph consists essentially of two electro-magnets supported on a vertical stem or upright *A*, which, when magnetized by a current, are capable of holding brass rods tipped with iron. The longer of these rods *B* is called the "chronometer rod," while the shorter one *C* is called the "register rod."

The operation of this instrument is as follows: A copper wire *J*, Fig. 46, is placed directly in front of the muzzle of the rifle, and is connected to the magnet in the instrument, Fig. 47, holding the rod *B*. At a distance of 180 feet from the muzzle of the rifle, is placed the target *G*, Fig. 46. This target through its terminals is also electrically connected to the instrument by two wires running from the target to the electro-magnet, which holds the register rod *C*.

Now upon the discharge of the cartridge, the bullet, leaving the muzzle of the rifle, cuts the wire *J*, breaking the circuit and allowing the chronometer rod *B* to drop. Then when the bullet cuts one of the copper wires passing through the target, it breaks the second circuit and allows the register rod *C* to drop, which in dropping, falls upon a trigger plate *D*, releasing a spring attached to a knife-blade. The spring, when released, causes the knife-blade to fly forward and make a nick in the chronometer rod *B* as the latter falls. The two circuits connecting with the electro-magnets holding

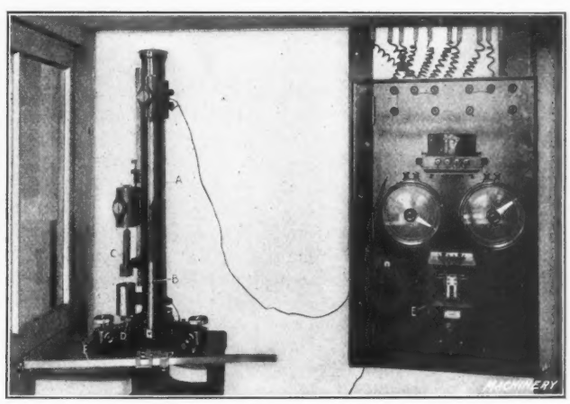


Fig. 47. "Chronograph," the Instrument used in Obtaining Muzzle Velocity

the chronometer and register rods can be broken simultaneously by means of an instrument *E*, called a "disjunctor," which forms a part of the chronograph. Now the distance between the nicks made by the knife-blade when both rods *B* and *C* are made to fall by the disjunctor *E*, and when they are operated by means of the bullet cutting the wires, is the time required for the bullet to travel from the muzzle of the rifle to the target. By means of a suitably graduated vernier scale *F*, the distance between the two nicks can be read in feet per second. The reading thus obtained is the average velocity, and is approximately the actual velocity at half the distance—90 feet.

Copyright, 1911, by THE INDUSTRIAL PRESS

Entered at the Post-Office in New York City as Second-Class Mail Matter

MACHINERY

DESIGN—CONSTRUCTION—OPERATION

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS

49-55 LAFAYETTE STREET, NEW YORK CITY

27, CHANCERY LANE, LONDON, W. C., ENGLAND

Alexander Luchars, President and Treasurer
Matthew J. O'Neill, Secretary

Fred E. Rogers, Editor
Erik Oberg, Franklin D. Jones, Douglas T. Hamilton, Chester L. Lucas, Associate Editors

The receipt of a subscription is acknowledged by sending the current number. Checks and money orders should be made to THE INDUSTRIAL PRESS. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

DECEMBER, 1911

PAID CIRCULATION FOR NOVEMBER, 1911, 25,139 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper, $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

EFFICIENCY IN MEN AND MACHINES

Judging by the success of the manufacturers of high-class machinery, the average machinery user realizes that it is good business policy—that is, a good investment—to equip his plant with nothing but the highest grade of machines and accesories. It is well known that although the first cost of such equipment is greater, it is found to be cheaper eventually, producing a greater output, requiring fewer repairs, and not being out of commission, due to break-downs, as often as inferior machinery.

If this is true of machinery, why is it not also true of men? In a great many cases we find well-equipped shops manned with cheap and comparatively unskilled labor. Some manufacturers do not believe there is the same economy in employing the best class of men that there is in using the best class of machines; but is it not reasonable to assume that the same rule that applies to the equipment also applies to the human element? A more intelligent man, a more highly skilled man, a higher priced man, is likely to be so much more efficient than an inferior workman that he really is the cheaper man in the end. It is not the price paid per hour that entirely determines the cost; the efficiency of the men in proportion to their pay is an important factor.

If it is good policy to employ a better class of men because they are more efficient, it is also good policy to pay a wage which is a little higher than the lowest wage for which the man can be hired. This does not seem to be the policy of some manufacturers, but it is a proposition which no one with any knowledge of human nature would attempt to contradict. The man who knows that he is paid only the lowest rate he can get elsewhere is likely to be an inefficient workman; he has no particular incentive to "hold on to" his job, except in dull times when work is scarce. The man who is paid a rate slightly higher than he might expect elsewhere is the most efficient man to employ, other things being equal. He usually does all in his power to make good, so that his efforts will enhance his value as a producer; and through the stimulus thus given him to exert his latent powers, his efficiency is increased, and a feeling of cooperation is established between him and his employer. There should be no feud between capital and labor when a business is so conducted that it works in the interest of all the parties involved.

* * *

ARBITRATION BY TECHNICAL JUDGES

Judge Learned Hand of the United States District Court, in the Southern District of New York, recently rendered an opinion in the case of Parke, Davis & Co., versus the Mulford Co. involving infringement of patents used in the manufacture of chemicals, in which he said:

"I cannot stop without calling attention to the extraordinary condition of the law which makes it possible for a man without any knowledge of even the rudiments of chemistry, to pass upon such questions as these. In Germany where the natural spirit eagerly seeks for all the assistance it can get from the whole range of human knowledge, they do quite differently. There the Courts summon technical judges to whom technical questions are submitted and who can independently pass upon the issues without blindly groping among testimony wholly out of their ken. How long we shall continue to blunder along without the aid of unpartisan and authoritative scientific assistance in the administration of justice, no one knows; but all fair persons not conventionalized by provincial legal habits of mind ought, I should think, to unite to effect some such advances."

In making this comment upon the present condition of the law in the United States, Judge Hand was merely expressing the thought underlying the plan of the New York Chamber of Commerce for the adjustment of commercial disputes by arbitrators selected from an official list. This plan provides, in a most practical way, for the disposition of technical questions arising in business by men peculiarly qualified by reason of their experience to deal with such questions. As the list covers men in all lines of business and industry, there is no longer any necessity for submitting such questions to untrained jurors, or judges unprepared for such technical questions.

* * *

THE HORSEPOWER AND THE KILOWATT

About the time of the Philadelphia electrical exhibition in 1884, an effort was made in scientific and engineering circles to substitute the kilowatt for the indefinite horsepower as the unit measurement of power; but the time was not ripe for such a radical change in engineering measurements. It is possible, however, that the agitation for this change that has recently been revived by the Committee on Units and Notation, representing various associations of German electrical engineers, will be more successful, as there is now a better appreciation of the value of using the kilowatt as a unit rather than the horsepower.

It must be admitted that the kilowatt is just as good a mechanical unit as an electrical one, and it has the advantage of being a logical rating, expressing a definite relation to the absolute system of measurements in general use for scientific purposes. It has been said that the kilowatt is the point of contact between the electrical and mechanical systems of measurement, and this statement is very much to the point. Why then continue to use the horsepower, which is a purely arbitrary unit, and which has no direct relation to anything mechanical, when we have in the kilowatt a much more natural unit of power measurement?

One of the advantages of the kilowatt is that it is an absolute international unit. A kilowatt in Germany, France and in the United States is the same, while that is not true of the horsepower. The latter, in countries using the metric system, is calculated as the equivalent of 75 kilogram-meters per second, which equals 542.5 foot-pounds per second, or 32,550 foot-pounds per minute—an appreciable amount less than the 33,000 foot-pounds constituting the British and American horsepower. The adoption of the kilowatt as a unit of power would avoid having dynamos rated in kilowatts while their driving machinery and electric motors are rated in horsepower.

No standards of measurement would be changed by the adoption of the kilowatt as the standard unit of power, because it is just as easy to express the equivalent of a kilowatt in foot-pounds per second or minute as it is to express the equivalent of a horsepower in those units.

GOOD JUDGMENT AS A BUSINESS ASSET

One of the most valuable qualities in a man having charge of an industrial undertaking—or of any business for that matter—is a keen perception of the relative importance of the various details of the business. This qualification has frequently been called a "sense of values." In some cases a manager will pay so much attention to minor details that serious losses occur in other parts of the business, to which he attaches less importance. A case illustrating this is mentioned in one of our contemporaries: In a certain drafting-room the men were instructed by the chief to draw all details so as to make it possible to use the simplest and quickest methods in the shop. Accordingly the men were required to see that the rivet-spacing on all flange angles should be so arranged that one templet could be used in the shop for both "legs." This rule frequently made possible a saving of fifty cents in the shop at an expense of several dollars in the drafting-room, to say nothing of the awkward and inefficient way in which the rivets sometimes had to be arranged.

That was a case where the man in charge had no conception of the relative importance of the work under his supervision. He strained at a gnat and swallowed a camel. And it is not only the men in charge of the industrial undertakings and those at the heads of departments who are afflicted with this shortcoming; it is frequently found in the shop. We see men finishing work within a thousandth inch where a thirty-second would be close enough. We see draftsmen making an elaborate drawing for a temporary job, where a simple pencil sketch would be sufficient. We see red-tape systems followed in cases where considerable economies might result if exceptions were made.

Errors of judgment in this respect are of course most costly when they are made by a man in charge of other men, because they are usually multiplied in the work of each of the men under him. Every man, and especially the man in authority over others, should carefully weigh in his mind the relative importance of the questions he must decide. The efficient management of an industrial undertaking or a department requires constant compromises between conflicting conditions; and the best manager, the best foreman, the best workman is the man who combines with other necessary qualities a highly developed sense of values.

* * *

GEAR-CUTTING PRACTICE

A great change in the gear-cutting business has developed during the past few years. The automobile manufacturers, who have become the largest customers of the gear-cutting shops, are no longer willing to accept spur and bevel gears of "commercial accuracy." They now demand gears of much greater refinement of accuracy and finish than were considered necessary for almost any machinery five years ago. While the automobile manufacturers may seem arbitrary in their demands, they are simply passing along the imperative demands for quiet running gears in transmission and rear axles made by their customers. They must meet these demands or fail to sell their cars.

Owners of cars—even the cheaper ones—will no longer tolerate the noisy rattletraps that were the rule rather than the exception in the early days of automobile production. As automobile manufacture has advanced, more and more attention has been given to the elimination of noise. Valve mechanisms have been enclosed to reduce to a minimum the rattle of cams and valve lifters. The advent of the so-called "silent engine" in which poppet valves and cams have been eliminated has still more accentuated the difficulties of the gear-cutting business. The gears remain as the last resort of the noise imp, from which he can be routed only by the use of improved gear-cutting machinery, careful work and inspection, and better methods all around.

The demand for hardened gears by the builders of high-priced motor cars is difficult to meet because of the inevitable distortion of the teeth due to heating the gear and cooling it in a bath. The ultimate solution of the problem of manufacturing high-grade hardened gears probably will be finishing by grinding on some form of generator grinder.

SELLING METHODS IN THE MACHINE TOOL TRADE

Editor MACHINERY:

I am not a knocker by nature, but once in a while I feel like getting out my ball-pein hammer. The present occasion for the resurrection of the hammer is the way in which the majority of manufacturers attempt to sell machinery. I am not knocking them because I want to hurt them, but because some of them need to wake up.

I have charge of a small shop in which metal and wood working machinery is used. Once in a while we purchase new tools, and my experience at such times convinces me that the machine tool trade is sadly in need of instruction, both in methods of selling and of advertising. Usually my experience runs something like this: I wish to buy, let us say, a 16-inch engine lathe. I turn to the classified list of advertisers in MACHINERY, make out a list of those who make tools of the kind I want, and then send each maker a letter giving the size and full description of the machine that I wish to purchase. In case there is anything about the machine that I wish to know, I ask about it, and finally, of course, I ask for the lowest price on the machine that I want. In addition to the price, I ask for such description of the machine as will enable me to judge of its value.

Now, I have learned to divide machine tool builders into two classes: those who manage the selling end themselves, and those who delegate the management of sales to their "local representatives." About two-thirds of our firms belong to the latter class. In my case the local representatives are New England representatives, usually having offices in Boston. The New England representatives may be classified in several ways. We may divide them into those who understand all about machine tools, and those who do not know anything about machine tools. We may also divide them into those who have authority to make concessions, and those who cannot make concessions without consulting the manufacturers. A third method of division is to divide them into those who do business by correspondence, and those who prefer to send along a salesman. Bearing these divisions in mind, let us see what happens to my correspondence. In the course of the next week or two, I receive letters from about one-fourth of the manufacturers who quote me prices and discounts. Sometimes they send the specifications of their lathe and sometimes they do not. If I am particularly interested in a machine for which the specifications are not sent, I write for them. A few manufacturers, perhaps fifteen or twenty per cent, ignoring the fact that I have already described the machine which I wish to purchase, write and ask what equipment I wish with the lathe. Most of them write me that my inquiry has been referred to their "New England representatives" Messrs. Blank and Dash. Sometimes I receive a catalogue with the letter, but usually I do not. In a few cases, the manufacturers do not answer my letter, but refer it to their New England representatives.

After a few days more, the New England representatives begin to get busy, and I receive a courteous letter from Messrs. Blank and Dash requesting information as to the equipment I desire. After furnishing the desired information, I receive a quotation, and sometimes I receive the specifications of the tool. Usually, however, I do not receive these specifications until I write a letter requesting them. In about one third of the cases Messrs. Blank and Dash have received full information of my wants from the manufacturers, and I get all the information I desire immediately. Sometimes the New England representatives want to get into "personal touch" with me. They send a young man to see me who carries a grip full of catalogues and a large fund of assurance. Usually he also has two ten-cent cigars. He arrives about ten o'clock in the morning on my busy day, and sits down to talk it over.

Now, if this young man is an engineer, and knows his business, and has authority to make terms, I can settle the matter one way or another in ten minutes. Usually, however, he does not know much about the line of goods he is trying to sell, and tries to disguise his ignorance by a superfluity of oratory. If I ask him about the details of the machine

he is selling, he explains that it is the greatest machine on the market; that it is very rigid; that special pains have been taken in its design; that the manufacturer had a great deal of experience in the manufacture of that tool; that it is the best all-around machine that can be found; that it is all "made with jigs," etc. Once, when I asked one of these young gentlemen if it was all jig work and if they didn't do some planer work on the tool, he assured me that they did not, and that every part of it was constructed by means of jigs. I am going to visit that wonderful shop the first chance I get. Usually, however, when I ask the salesman about such points as these, he frankly admits that he doesn't know, that he is not an engineer, and that he cannot give definite information as to the principal dimensions of his machine.

Now I would like to know why a man of that kind should be sent out to sell machinery. When a man is sent out to sell a typewriter he is carefully trained to present the good points of his machine and to fully explain the details of its mechanism. He knows that when he tries to sell the typewriter, he will have to sell it to a man who knows all about typewriters, or who will seek advice from some one that does. Buyers of machine tools usually know more about what they are going to buy than do any other class of customers. Men who sell machine tools ought to be experts who know how to intelligently present their case, and who can devise methods of work and make estimates of time required. It will probably cost more to employ such salesmen, but, in my opinion, it is waste of money to employ any other kind. When I am considering which of two lathes of nearly the same price is the better, I do not care to be told by the salesmen of each of the two manufacturers that their machine is the best on the market; that it will pull the heaviest cut; that it will do more work than any other machine; that it is the heaviest machine of its capacity built, etc. What I want to know is whether the size of the spindle bearing is 2 by 3 or 3 by 4 inches. I want to know the size of the belt and cones, and the ratio of the back-gearing; I want to see the details of the apron, and to know what materials go into the different parts. Then I can form an intelligent idea as to the relative value of the two machines. Mr. Manufacturer, when I try to buy a lathe, I know just as much about using it as you do about making it. Why don't you try to get together with me on that basis?

Why should a man who wants a machine and knows what he wants, have to wait six weeks and write four letters before he can get quotations? Why does he have to write another letter before he finds out how much discount he is going to get on the quotation? When a man wants to buy a carload of 2-inch pipe he can find out in three days what the best prices will be. He is not referred to a local representative, he is not asked whether he wants black pipe or galvanized. He gets the full information, and if the manufacturer has any doubt as to whether he wants black or galvanized pipe, he quotes on both.

I must admit that when I buy goods I am prejudiced in favor of the man who shows a little common sense in the way he tries to sell me machinery. If he knows how to sell tools, it is pretty good evidence, to my mind, that he knows how to make tools, and I am apt to think that his machinery is just a little bit better than anyone else's. Because he has presented his case fully and completely in the first place, his machine becomes a standard by which I judge the others. If they fall short of it in any particular, I am apt to think that they are inferior, even when they may be better in some points. Perhaps there is an advantage in having a local representative, but I fail to see it. It is sometimes an advantage for a firm to have someone to look after their interests in a particular locality, but why should the customer be prohibited from doing business with the firm itself?

In some respects the best example of modern selling methods is the up-to-date department store. The department store is not usually a manufacturer, but no department store would think of anything else than dealing directly with the manufacturer and selling directly to the customer. In other words, the department store is organized for the purpose of eliminating the jobber and the local representative. In the long run that manufacturer who gives his customers the greatest value for the least money will do the most business. So long as a manufacturer tries to do business through a middleman, so long will he increase to his customers the price of goods of a given quality, by the profits and expenses of the middleman. It is not a mistake for the average manufacturer to attempt to do business in this way? My own experience is that those manufacturers who do not employ local representatives, either sell the same quality of machinery for a lower price, or sell a better quality for the same price.

We hear a good deal of scientific management in these days, but we hear very little about the scientific management of the sales department. Our manufacturers try in every possible way to reduce the expenses of manufacturing, and to devise new and more efficient methods; but we never hear of an attempt to reduce the expenses of salesmanship or to buy the greatest selling power for a given amount of money. Our manufacturers never give serious consideration to anything relating to salesmanship except the medium in which they advertise and the form of their advertisement. If the claims of the advocates of scientific management are correct, and we can reduce manufacturing expenses by twenty to fifty per cent, is there not also a possibility that the average manufacturer can reduce his selling expenses by the same amount?

The question of what to advertise and how to advertise it is a matter that ought to receive more attention than it does. We must remember that the men who buy machine tools know something about them. Consequently, the thing which they are interested in is the actual construction of the tools. Descriptive illustrations are the most powerful and telling arguments with most of us. A section through the headstock of a lathe showing the method of adjusting the parts, the size of the bearings, etc., helps to sell such a tool. A view of the interior of the apron will convince a skeptic, if the machine is a good one. A series of good articles pointing out the several features of some particular machine and calling attention to other machines in which the same points are embodied, appeal to the man who knows his business. The kind of advertising that we are interested in is the kind that instructs us. A great many advertisements will attract our attention, but unless they teach us something, they are of no value in selling goods.

An advertisement which has a price attached teaches us something; one which invites us to write for prices and discounts teaches us nothing. Very few people will write for prices and discounts unless they are actively interested in the particular machine advertised. Advertising his prices does not put a manufacturer to any disadvantage, for if his price is low (and he can afford to make it low if he advertises it), the fact that he advertises it will attract trade if he at the same time convinces his readers that his article is a good one. If his price is higher than that of his competitor, the reader naturally looks to see if the article is not a better one, and if it is enough better than the one he has contemplated purchasing, he will give his order to the manufacturer who advertises his price. Of course the argument may be made that if a manufacturer advertises his price, his competitor is able to shade his price, and take the business away. In order to do so, without maintaining an expensive selling organization, he must advertise his own price. The manufacturer will answer, of course, that this will result in a price war. If the manufacturer's shop is properly organized, if he is willing to manufacture for a reasonable profit, and if he handles his business economically, he has nothing to fear from such a war. If, on the other hand, his shop is not properly organized, his business is not on a sound basis, or he wishes to obtain exorbitant profits, such a war will naturally be distasteful.

The present system of doing business has arisen not because it is the best system, but because a large number of estimable gentlemen desire to make their living by their wits and not by their hands. They prefer smoking ten-cent cigars with the purchasing agent to running a machine in the shop. Hence we have an army of "salesmen," "local

representatives," "district agents," "sales managers," etc., all of whom foregather around the saucer of profits and greedily lap up the cream.

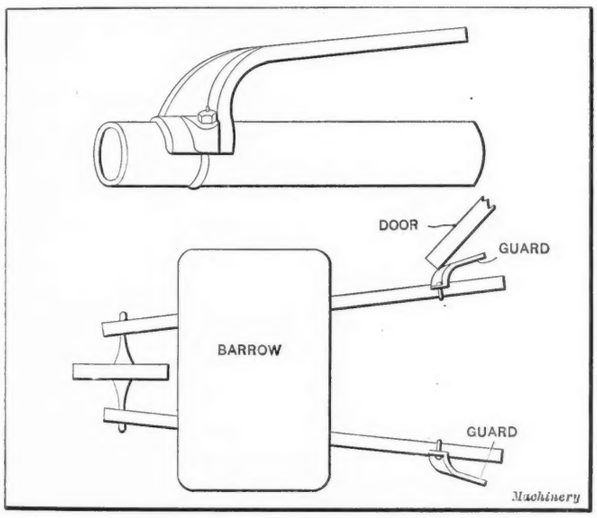
I have written at considerable length on these matters, because they have been in my mind for some time, and because I feel that they are of importance to the well-being of the machinery trade. Anything which will reduce the prices of machinery without reducing the reasonable profits of the manufacturer or the wages of the working man is certainly to be welcomed. Anything which will make it easier for the prospective purchaser of machinery to obtain what he wishes is desirable. Our present system of doing business is organized for the benefit of the middleman, who is usually a man who knows a great deal more about "business" than he does about machinery. What we need to do is to bring the manufacturer and the purchaser into direct contact, and the best way to do it is by the methods that have been developed by our modern department stores.

Durham, N. H. FORREST E. CARDULLO

* * *

FINGER GUARD FOR WHEEL-BARROW HANDLES

The accompanying illustration, reproduced from the *Journal of Industrial Safety*, shows a guard which is particularly useful when pushing wheel-barrows through a doorway, especially when the door is kept closed by means of a spring or weight. Anyone who has ever scraped his knuckles on some solid object while pushing a wheel-barrow will appreciate the merits of this simple device. It consists of a steel or malleable-iron



Finger Guard for Wheel-barrow Handles

casting, as shown, attached to the wheel-barrow handles at the place where the hands usually rest, by U-bolts about ⅜ inch in diameter. The castings should be made about 6 inches long, and 2 inches wide at the base, and may taper to about 1¼ inch at the point, being about ½ inch thick. The guards are curved so that they stand out about 2 inches or somewhat more from the handle. Guards of this type will save the knuckles a good many unpleasant experiences.

* * *

The research laboratory of the General Electric Co. has developed during the past year, a method for producing ductile tungsten and molybdenum which will be of the utmost importance in the further development of the tungsten filament lamp. The ductile tungsten now produced would almost seem to be a new substance, tungsten having always been considered to be hard and brittle and not ductile, either at ordinary temperatures or when heated. The ductile tungsten is a bright steel-colored metal, capable of being drawn into the finest wire, the tensile strength increasing with the drawing. A wire 5 mills in diameter has a tensile strength of 490,000 pounds per square inch, while one of a diameter of only 1.2 mill has a tensile strength of 610,000 pounds per square inch.

A NEW GEAR CHART*

By C. F. HETHERINGTON†

The accompanying gear chart was devised to serve as a rapid means of solving the gear problems that are encountered in machine design work. The engineer engaged in the preliminary design of a new machine may not care to spend a great deal of time on calculations for the strength of the minor details; at the same time, if he is a careful engineer, he will not care to base the lay-out purely on guesswork; when he has completed his first general design, he should feel confident of the later satisfactory development of the details.

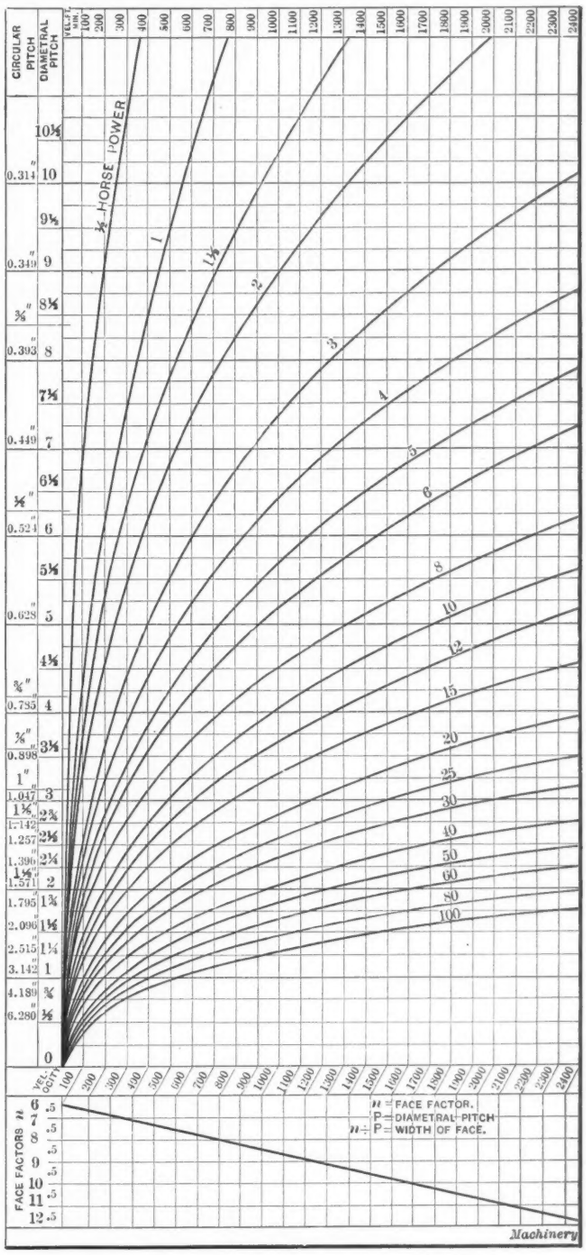


Fig. 1. Chart for Cast-iron Gears with Molded Teeth

The writer had been in the habit of consulting the catalogues of various gear manufacturers in making his selection of gears, but it often happened that discrepancies were dis-

* For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: "The Strength of Helical Gearing," October, 1908, engineering edition; "The Variation of the Strength of Gear Teeth with the Velocity," January, 1908, engineering edition; "Strength of Gears," December, 1906, engineering edition; "The Strength of Gear Teeth," October, 1906, engineering edition; "Use of Diagrams and Tables for the Solution of Problems in Gearing," March, 1904, engineering edition. See also MACHINERY'S Reference Series No. 15, "Spur Gearing," and No. 37, "Bevel Gearing," and MACHINERY'S Data Sheet Series No. 5, "Spur Gearing," and No. 6, "Bevel, Spiral and Worm Gearing."

† Address: Care of Hetherington & Berner, Indianapolis, Ind.

covered by subsequent calculations or by comparison with other catalogues, when the details of the design were taken up. As a result, various authorities were consulted from time to time, and from the theories of the different authorities the writer selected such elements as appeared to be rational and practicable, and combined them in the formula given in the following. From this formula the gear chart, Fig. 1, was plotted by assigning different values to the horsepower and velocity factors in the formula.

The Lewis formula, as first proposed by Mr. Wilfred Lewis in a paper published in the proceedings of the Engineers' Club of Philadelphia, January, 1893 (see MACHINERY's Reference Series No. 15, "Spur Gearing," second edition), has been recognized as authoritative for a number of years. It is, however, not in such a form as to lend itself to rapid solution of problems, and furthermore the writer does not think that it can be properly applied to problems involving ordinary cast-iron gears with cast rather than cut teeth. The method of derivation of the Lewis formula was given in the How and Why columns of MACHINERY in the September, 1911, number, and it is not necessary to deal with it here. The method used, however, seems to the writer more refined than is justified when cast gear teeth are considered, especially when an allowance for backlash has been made in the design of the gear; but for nicely cut teeth there seems to be no better standard than the Lewis formula, and the writer uses it without hesitation for this class of gearing.

The formula from which the gear chart for cast-iron gears with cast teeth was plotted is as follows:

$$P = \sqrt{\frac{(2900 + V) \times V}{11.3 \times \text{H.P.} \times (1100 + V)}}$$

in which

P = diametral pitch,
V = pitch-line velocity in feet per minute,
H. P. = horsepower to be transmitted.

In the development of the formula, the load is considered as borne by one tooth at its extremity, as indicated in Fig. 2, and the tooth is regarded as a cantilever. The ordinary proportions for the standard 15-degree involute tooth are used.

Let

P = diametral pitch,
p = circular pitch,
$L = 0.7\ p = 0.7\ \pi \div P$,
$t^* = 0.5\ p = 0.5\ \pi \div P$,
F = width of face,
W = load on tooth,
S = section modulus of tooth section at root,
R = safe fiber stress,
B = bending movement.

Then

$$B = L\,W = \frac{R\,F\,t^2}{6}$$

Substituting,

$$\frac{0.7\,\pi\,W}{P} = \frac{R\,F\,(0.5\,\pi)^2}{6\,P^2}$$

To determine the safe stress R, the following formula was adopted as giving fair average values:

$$R = \frac{7{,}200{,}000}{V + 1100}$$

It will be seen that the safe stress as found by the above formula begins with a static stress of 6500 pounds per square inch, and decreases as the velocity increases. This formula is similar in form to that used by the International Correspondence Schools.

It is considered good practice to make the ratio of the width of face to pitch increase with the velocity, and the writer adopted as his rule for this variation the formula:

$$F = \frac{(2900 + V) \times \pi}{1450 \times P}$$

* For pinions with a small number of teeth, the value of t as given is somewhat too large, as here the undercutting at the root of the gear teeth causes the width at the root to be less than at the pitch line.—EDITOR.

Hence,

$$W = \frac{\dfrac{7{,}200{,}000}{V + 1100} \times \dfrac{(2900 + V) \times \pi}{1450 \times P}}{5.35\,P}$$

$$W = \frac{2910 \times (2900 + V)}{P^2\,(V + 1100)}$$

$$\text{H. P.} = \frac{W\,V}{33\,000} = \frac{2910\,(2900 + V)\,V}{33{,}000\,P^2\,(V + 1100)}$$

Hence,

$$P = \sqrt{\frac{(2900 + V)\,V}{11.3 \times \text{H. P.} \times (V + 1100)}}$$

It will be observed from the derivation of the formula that the values of horsepower or pitch which are obtained from the chart are all dependent upon a certain face width, and in order to facilitate the determination of this face width, the lower diagram is provided. For instance, suppose that a diametral pitch of 2½ has been determined by the upper chart as necessary to transmit 30 horsepower at a velocity of 1150 feet per minute; then the proper face width will be found by following the velocity ordinate for a speed of 1150 to its intersection with the oblique line in the lower chart. Horizontally opposite this point, at the left, will be estimated the factor 8.75; the face width will then be $\frac{8.75}{2.5} = 3.5$ inches.

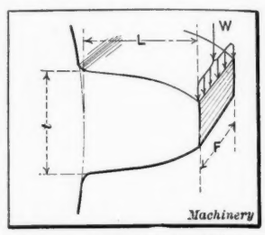


Fig. 2. Assumed Condition of Loading Gear Tooth used in Deriving the Chart, Fig. 1

The chart may also be used for gears made of steel casting by using a factor representing the ratio between the strength of cast iron and steel. Thus, if we take 6000 pounds per square inch as the safe stress for cast iron at 100 feet per minute velocity, and 19,500 pounds per square inch as the safe stress of steel castings at the same velocity, we establish a ratio of 1 to 3.25 between cast iron and steel castings, and the formula should be written:

$$P = \sqrt{\frac{(2900 + V)\,V \times 3.25}{11.3\ \text{H. P.} \times (V + 1100)}}$$

$$= \sqrt{\frac{(2900 + V)\,V}{3.5 \times \text{H. P.} \times (V + 1100)}} \quad \text{for steel castings}$$

Hence, the diametral pitch for steel $= \sqrt{3.25} = 1.8$ times the pitch for cast iron, or the horsepower transmitted by a steel gear will be 3¼ times that of a cast-iron gear of the same pitch and velocity.

The chart is plotted for velocities up to 2400 feet per minute, but for cast-iron gears with cast teeth the writer does not recommend velocities exceeding 1500 feet per minute. The higher values may be used in calculations for steel gears.

Example of the Use of the Gear Chart

What pitch is required for the teeth of a gear which is to transmit 20 horsepower, the pitch line velocity being 400 feet per minute?

In the chart, Fig. 1, the 20-horsepower curve intersects the ordinate for 400 feet pitch-line velocity very nearly on the abscissa for 2 diametral pitch. To find the width of the face, find the face factor n, in the lower part of the chart, for a velocity of 400 feet per minute. This factor is about 7. Hence, the face width, $n \div P$, in this case equals $7 \div 2 = 3\frac{1}{2}$ inches, P being the diametral pitch.

* * *

According to the *Daily Consular and Trade Reports*, a new radiator intended for the motor of an airship has been designed. The motor develops 300 horsepower, and the radiator for it is made entirely of aluminum. The radiator is 4 feet 7 inches high, 4 feet 7 inches wide, and 8 inches deep. The hourly capacity of the radiator is 6868 gallons; its weight is 145 pounds when empty, and 209 pounds when full of water.

MAKING COLLAPSIBLE TUBES BY THE EXTRUSION PROCESS*

By CHESTER L. LUCAS†

The extrusion process is extensively used for making collapsible tubes of tin and lead, for containing dentifrice, artists' colors and other preparations. Through the courtesy of Mr. L. T. Sheffield, president and treasurer, and Mr. W. K. Sheffield, secretary of the New England Collapsible Tube Co., of New London, Conn., the writer is enabled to present to the readers of MACHINERY an account of the operations employed in the work of making these collapsible tubes. The business of the company was originally established by the late Dr. Sheffield, in 1850, as a dentifrice manufacturing business. He made at that time only the tubes he required in putting out his preparations. Later, however, the demand for good collapsible tin tubes became so strong that the company commenced to make them for outside concerns, and now the tube department has grown to be far larger than the dentifrice department.

The best collapsible tubes are made from pure tin. Lead is often used for tubes for paste, glue, and ink; but for toilet preparations, like dentifrice, only the purest tin is employed, and this article will treat entirely of the making of collapsible tin tubes. Tin ore is found in Germany, Spain, Russia, Malacca, Australia, Mexico and the United States. The amount of tin ore mined in the United States, however, is very small, and not nearly sufficient to meet the demands of this country. The very best tin is obtained from the Straits of Malacca, as this tin is particularly free from impurities. This is a very important requisite in tin for the extrusion of collapsible tubes for dentifrice, because foreign matter would not only cause the tubes to be poor, but the

Fig. 1. Collapsible Tin Tubes made by Extrusion

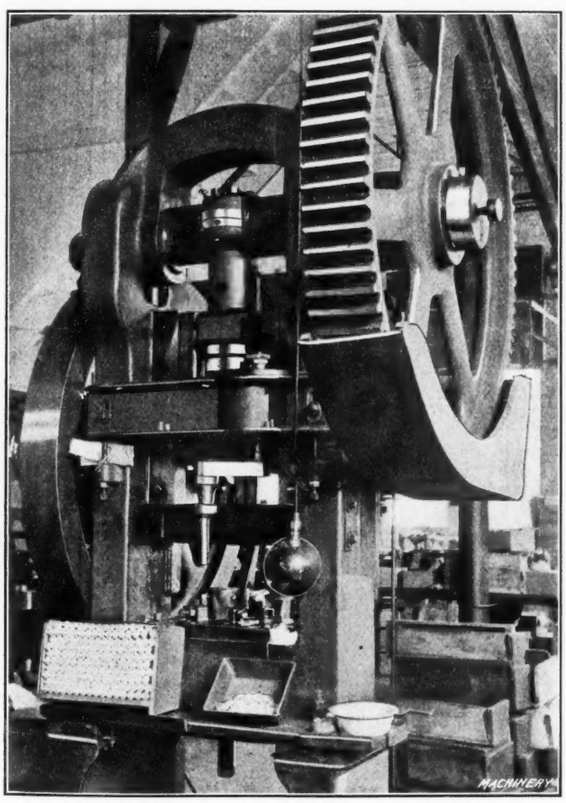


Fig. 2. Extrusion Press made by the E. W. Bliss Co., Brooklyn, N. Y.

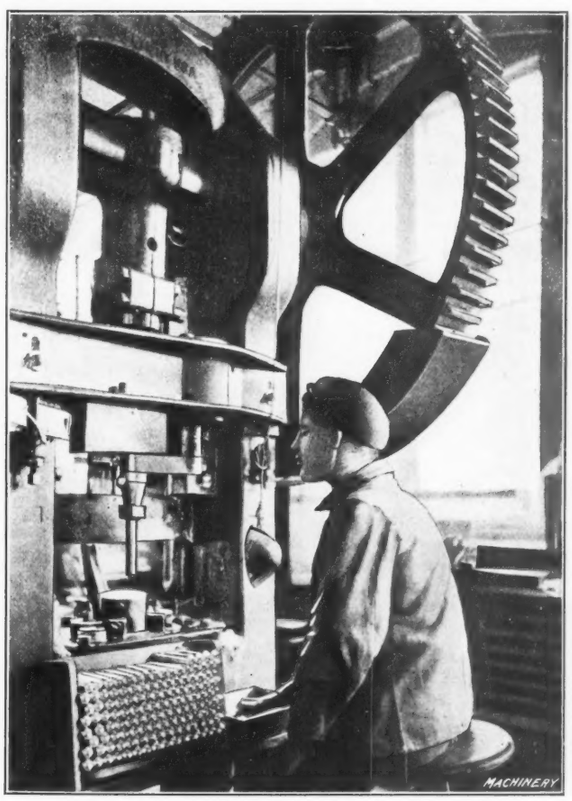


Fig. 3. Making Collapsible Tubes at the Rate of 600 per Hour

* See MACHINERY, October, 1911, engineering edition, "The Extrusion Process"; November, 1911, "The Extrusion of Shells and Tubes."

† Associate Editor of MACHINERY.

quality of the dentifrice would be affected, and moreover there would be constant trouble from injury to the dies.

Fig. 1 illustrates a few finished collapsible tubes and their caps. Those marked *A* have been decorated by lithographing; those marked *B* have been embossed; while those marked *C* are plain tubes onto which labels may be pasted. Collapsible tubes may be made as large as 2½ inches in diameter, and of any length up to 9 inches. The thickness of the walls of the tubes ranges from 0.005 inch to 0.010 inch, varying with the size of the tube. If desired, raised lettering may

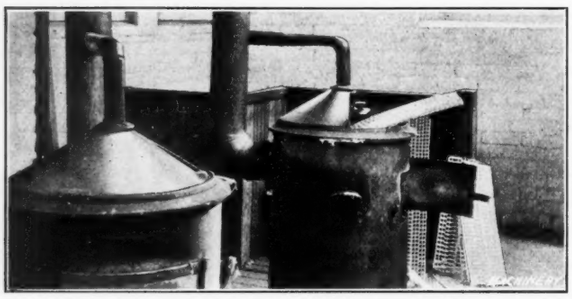


Fig. 4. Melting Furnaces where the Tin Ingots are cast into Nine-pound Slabs

be produced upon the shoulder of the tube. The opening in the top of the tube may be of any size, either round or oblong in shape.

The cold extrusion of collapsible tin tubes is totally different from the hot extrusion process for solid shapes described in the October number of MACHINERY, and it is just the reverse of the cold tubular process described in the November number. The extrusion of tin, however, is much more easily accomplished than the extrusion of copper and brass. Briefly stated, collapsible tin tubes are made by placing a round blank of tin in a die-cavity shaped like the head of the tube, and of the same internal diameter as the external diameter of the tube to be made. Then a punch, whose greatest diameter is the same as the inside diameter of the tube, comes down on the blank. It forces the metal into the bottom of the die, and squeezes the excess metal upward through the narrow annular opening between the outside of the punch and the inside of the die-cavity. The tin literally "crawls" up the punch as it is extruded. When the punch ascends, it automatically swings outward to allow the operator to remove the completed tube, otherwise there would not be room to withdraw the tube from the punch. The threading of the head is done in another operation in this factory, although some companies make the die in halves, with half of the threaded section in each, necessitating the opening of the die after each stroke of the press.

The general method of making collapsible tubes is illustrated in Fig. 2, where the blanks are shown in the square

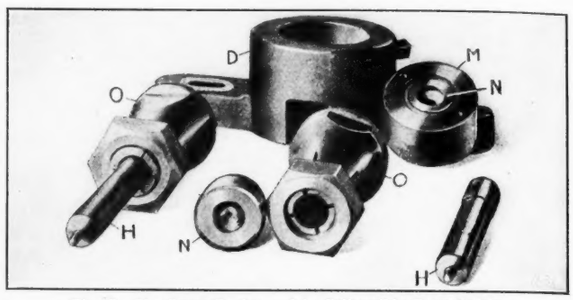


Fig. 5. The Press Tools used in Collapsible Tube Making

pan, and the extruded tubes in the rack at the left. Fig. 3 shows the operator just completing a gross of 5-inch tubes, representing about fifteen minutes' work. This illustration also gives a good idea of the size of the press.

Preparing the Stock

The particular grade of tin used by this company for collapsible tube making comes from the Straits of Malacca and is known as Penang tin. It reaches the factory in the form of 130-pound pigs, and is then re-melted in the furnaces shown in Fig. 4 and cast in slabs weighing nine pounds each. These slabs are about six inches wide, fifteen inches long and one-half inch thick.

The slabs are taken to a pair of rolls and reduced to a thickness ranging from 0.110 to 0.220 inch, varying with the length of tube that is to be made. For a five-inch tube, the metal is rolled to 0.190 inch. The next operation consists in blanking the disks for the tubes. These disks, three of which appear at *P*, Fig. 8, are cut to the same diameter as

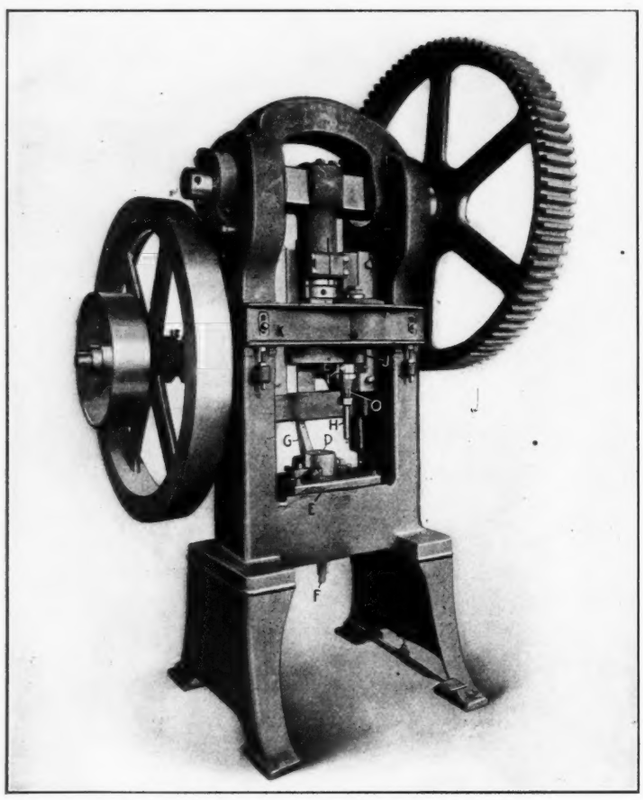


Fig. 6. Details of Arrangement of Extrusion Press

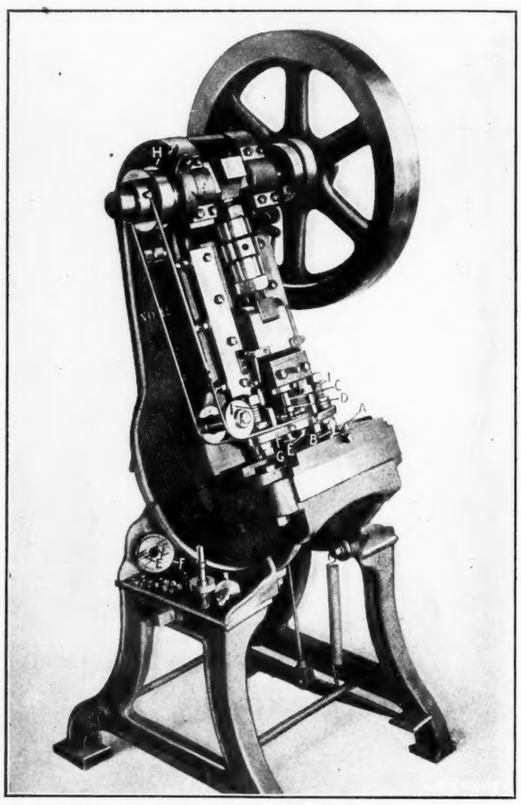


Fig. 7. Bliss Cap-forming Press with Unscrewing Attachment

the diameter of the tube that is to be made, and in blanking, they are slightly "crowned" to conform to the inclined shoulder of the tube. This crowning is accomplished by merely chamfering the end of the blanking punch to the proper bevel; the die is perfectly flat. The blanking press is equipped with a roll-feed, and the rolls are knurled, so as to grip the sheets firmly. In Fig. 4 may be seen some of the sheets from which blanks have been cut, and which are sent back to the melting room for re-casting into slabs.

The Extrusion Presses

The operation of extruding collapsible tubes and the presses used are without doubt the most interesting features of the work. Two of these presses are shown in Figs. 2 and 3; and in Fig. 6 the details of the press and dies are well illustrated. For the large tubes, one-inch diameter and over, the E. W. Bliss Co.'s No. 63 press is used, and Figs. 6 and 7 show representative Bliss presses for making collapsible tubes and their caps. The No. 63 press is rated as a five-ton press, and its chief point of distinction, aside from its powerful construction, is its peculiar punch action, which will be described later. Referring to Fig. 6, *D* shows the die-shoe held to the bolster *E*, which latter is bolted to the bed of the press; *F* shows the end of the knock-out rod operated by lever *G*. The punch *H* is held in the arm *I*, which turns upon shaft *J*. Front plate *K* is adjustable, and its inner side is recessed for the cam that swings the punch-arm and punch away from the die. As the ram descends, this arm slowly swings so as to bring the punch in alignment with the die. It reaches the point of alignment just before the end of the stroke, so that at the time the end of the punch strikes the blank, the punch descends vertically. In Fig. 3 the arm has just started to swing outward on the upward stroke; in Fig. 2 it is half-way out; and in Fig. 6 the arm is shown at the end of its outward swing, giving the operator ample room to withdraw the tube from the punch. Knock-out rod *F* frees the end of the tube from the die, allowing the tube to remain on the punch as it ascends.

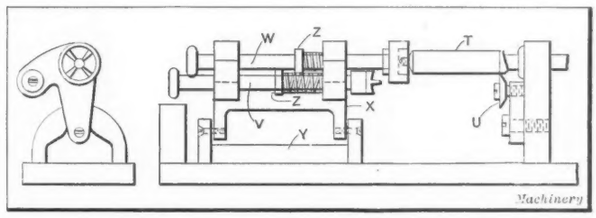


Fig. 12. Principal Parts of Tube Trimming Machine, as seen from the Rear

In operating an extrusion press of this character, the operator places the blanks in the die with his right hand and removes the tubes from the punch with his left hand. The speed with which the metal "crawls" up the punch is surprising, but it must be remembered that the extrusion of a five-inch tube must take place while the punch is descending the last one-eighth inch. The operator is obliged to wear a glove upon his left hand on account of the heat imparted to the tube by the extrusion. A skilled operator is able to "catch" nearly every stroke of the press. When making these 1-inch by 5-inch tubes he will turn out 600 tubes per hour, and on the smaller tubes, ½-inch by 2½-inch, using a smaller press of the same type, the average production is 1500 tubes per hour.

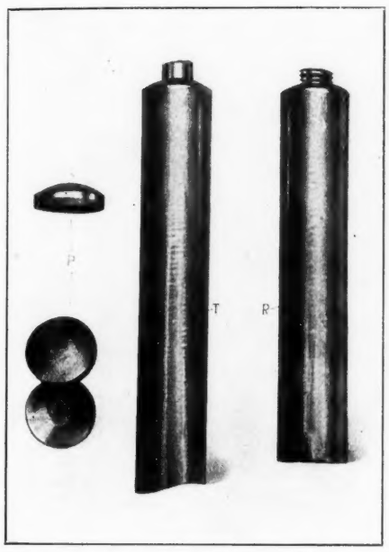


Fig. 8. The Three Operations in Making a Collapsible Tube

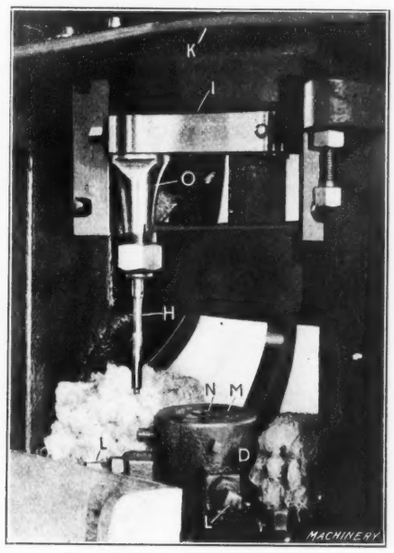


Fig. 9. Die and Punch in Position in Press

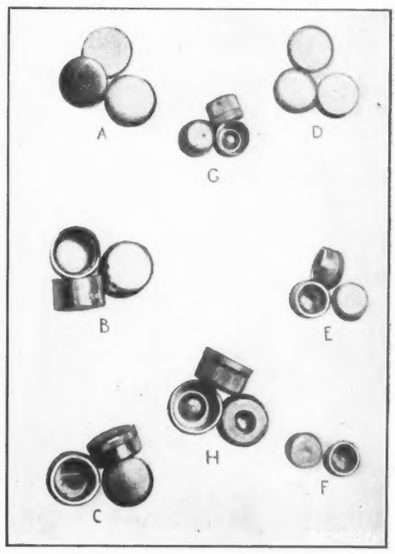


Fig. 10. Caps of Different Sizes and Styles in Various Stages of Completion

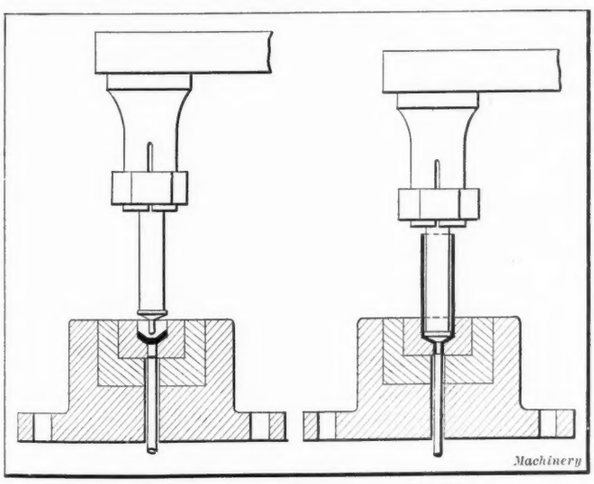


Fig. 11. Principle of Making a Collapsible Tube

The Dies for Extruding Collapsible Tubes

Figs. 5 and 9 illustrate the parts of the dies and punches. Fig. 9 shows a close view of the tools in the press and Fig. 5 shows the tools as they appear out of the press. At *D* is shown the die-shoe, held to the press by the two ears shown in Fig. 5, and adjusted laterally by the four screws *L* indicated in Fig. 9. Within this die-shoe rests the die-ring *M*, made of tool steel and carefully hardened and tempered. This ring acts as a support to strengthen the die *N* shown within the ring; this die is also separately shown at the front of Fig. 5.

The die *N* is made of the best tool steel and its cavity is made just the size and shape of the outside of the head of the tube, except that the hole that sizes the nose extends clear through this die to admit the knock-out. Thus the knock-out is employed to form the bottom of the die as well as to eject the finished tube. If the shoulders of the tubes require lettering, a hob is made with the lettering raised. By placing this hob in the die-cavity, the letters are all

stamped into the die at the same time. A collapsible tube die must be very smooth and highly polished in order that the metal will flow easily and take on a bright finish. This polishing is started with fine emery and oil and the final high polish is obtained with crocus and oil. The final polishing must be done after the die has been hardened and tempered to a faint straw color.

The punch used in extruding collapsible tubes has several distinctive features that are peculiar to this line of work. Two of these punches are shown at *H* in Fig. 5. The working part of the punch is made about one inch longer than the tube that is to be produced, and two inches additional length is left for the shank. The shank of the punch is held in the punch-holder *O* by tightening the nut upon the tapered sleeve. The part of the punch that does the actual work is the tip end, having the largest diameter. To illustrate this more clearly, Fig. 11 shows two collapsible tube punches and dies; in one case the blank is shown in position in the dies, and in the other the result of the operation is indicated. From these it will be seen that the long pilot forms the hole at the shoulder and outlet. As the pressure upon the blank is increased, the recess in the die becomes filled with metal and the excess metal is squeezed up past the end of the rib on the punch. As the pressure is continued, the shoulder of the tube constantly becomes thinner; the displaced metal is forced into the walls of the tube, thus increasing its length. It is obvious that after the metal has been squeezed past the ribbed end of the punch, its path is clear, for the upper part of the punch is considerably smaller in diameter than the inside of the tube. For a one-inch tube, the die-cavity is exactly one inch; the ribbed end of the punch would measure about 0.985 inch; and the body of the punch would be approximately 15/32 inch in diameter. The punches are made of Jessops steel, hardened, and the temper drawn to a light straw color, except in the slender pilot, which is drawn very much lower. The punch-holder *O* is threaded into the swinging arm *I* shown in Fig. 6.

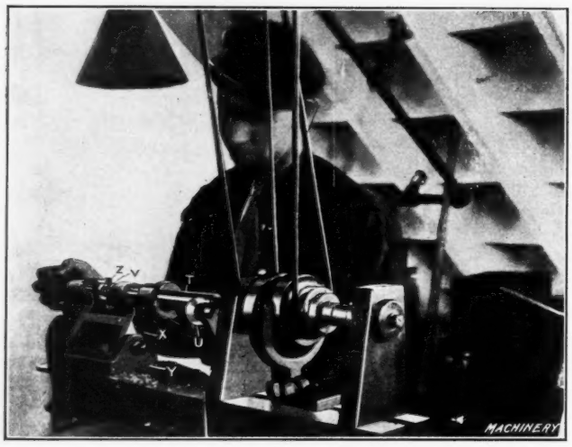


Fig. 13. Trimming Large Tubes

Trimming the Tubes

When the tubes come from the extrusion presses they appear as shown at *T* in Fig. 8. As will be noticed, the opening in the head is not cut through, nor is the head threaded. Better results are obtained by cutting the thread at the time the tube is trimmed. Figs. 12 and 13 show one of the tube trimming and threading machines of a type designed especially for the work and patented by this company. As will be noticed in the illustrations, the machine is similar in construction to a bench lathe. The tube is slipped over an arbor, and a rotary trimming wheel *U* which the operator swings into contact with a cutting edge on the arbor, thus trimming the tube to standard length, is pivoted upon the front of the headstock. The sizing and threading of the head of the tube is done with tools operated from the tailstock. This tailstock is of novel construction, having two operating spindles *V* and *W*, located at a fixed distance apart in a solid casting *X*. This casting is hinged upon a block *Y* bolted to the bed of the lathe, so that either of the spindles may be brought into line with the tube arbor at will, by throwing the tailstock casting either forward or backward. Stops are provided to insure the proper alignment of the two spindles in either position, and at the front there is a locking lever to hold the tailstock firmly in the desired position while the spindle is at work. Provision is also made for throwing the tailstock back far enough to have both spindles out of the way, permitting the tube to be withdrawn from the arbor.

When the tailstock is thrown toward the operator, the rear spindle *V* is in line. This spindle carries a combined counterbore and drill that clears out the hole in the head of the tube and faces off the end so that the cap will go on for a proper distance. If the tubes have oblong openings, so that the paste will "come out like a ribbon," a counterbore alone is used, merely facing off the top until the opening is clear. Next, the tailstock is thrown backward, bringing the threading die on spindle *W* into line. The head of the tube is threaded, and by pressure upon a foot treadle, the rotation of the tube arbor is reversed, thus unscrewing the tube from the die. The reversing clutch, as well as the straight-belted and cross-belted pulleys may be seen in Fig. 13. The travel of the counterboring and threading spindles is limited by stop-collars *Z*. In operation, the spindles are simply pushed forward, and spiral springs return them to their normal positions. In Fig. 8, at *P*, *T* and *R*, are shown the three steps in making the tubes.

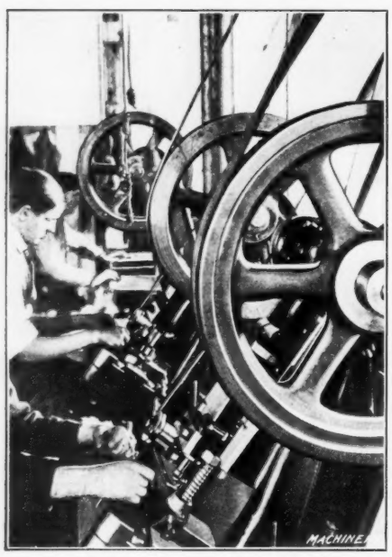


Fig. 14. Cap Blanking and Cap Making Presses

Fig. 15. Trimming the Large Caps

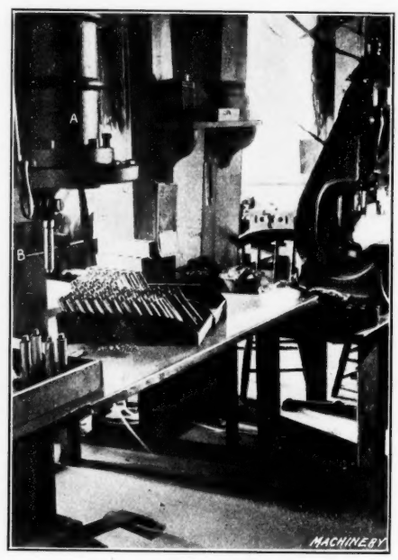


Fig. 16. Filling the Tubes

Cap Making

The caps for collapsible tubes are made in an entirely different manner from the tubes, although the blanking and finishing operations are very much the same as those employed in the tube making. The metal for the caps for 5-inch tubes is rolled to a thickness of 0.140 inch; the blanks are cut ½ inch in diameter, and the punchings are not crowned as were the tube blanks. In the background of Fig. 14 may be seen a cap blanking press, while in the foreground are shown the working parts of two cap forming presses.

Forming the Caps

The operation of forming the caps is an interesting piece of press-work, and the principles should be applicable to other

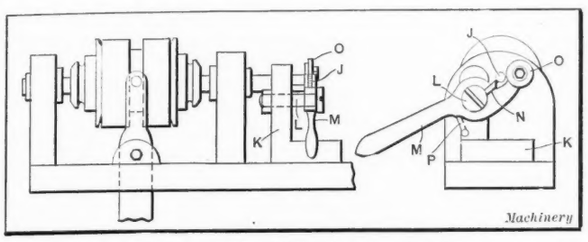


Fig. 17. Details of Cap Trimming Machine

lines of manufacturing. By referring to Fig. 7, the operation of the tools may be clearly followed. The die is shown at *A*, and upon its top surface there is a slide *B* that facilitates the feeding of the blanks to the working part of the die, without danger to the operator's fingers. The punch *C* has its tip end threaded with the same size thread as that on the tube that the cap is to be used with. The die-cavity is of the same diameter as the outside of the cap to be formed. Thus, when the punch strikes the blank, the tin is "crowded" around the sides of the punch, being confined on the outside by the limits of the die-cavity. This operation wedges the blank tightly into the die-cavity, but as the metal is just as tightly pressed into the threads upon the punch, the cap is readily withdrawn when the punch ascends.

The manner in which the cap is removed from the threaded punch is of interest. As the punch rises from the die, a beveled shoulder *D*, on the upper part of the punch body, comes into contact with the ends of three set-screws, located at the upper ends of the gripping fingers *E*. As these fingers are centrally hinged, the effect of this contact of the bevel-edged shoulder against the set-screws on the upper ends of the gripping fingers is to throw the tips of the fingers together, causing them to grip the cap as it rises on the punch. These gripping fingers are pivoted in a circular plate that is fitted to a bearing in stripping plate *G*. One of these circular plates, of the two-finger style, is shown at *F* at the side of the press. By means of a pulley *H* on the driving shaft, run independently from above, so as to make possible a higher speed, the gripping finger plate is kept constantly revolving. Thus, as soon as the cap is gripped by the fingers, it is rapidly unscrewed from the punch. During this operation, the punch is rising, and in order that the cap will not be pulled away from the gripping fingers, the stripping plate *G* that supports this mechanism is arranged to slide upward upon pins *I*, thus keeping pace with the ascending punch. When the cap has been unscrewed, the punch continues to rise until the set-screws slide off the shoulder at the bottom, thus releasing the fingers and allowing the cap to slide into a box at the rear of the press. Some caps have a monogram embossed upon the top; this part of the work is easily included in the forming operation by engraving the design in the bottom of the die.

Trimming the Caps

Machines for trimming and knurling the caps are shown in Figs. 15 and 18, and in detail in Fig. 17. The trimming machine in Fig. 15 is used on the large caps, and the machines in Fig 18 take care of the smaller sizes. These machines all work upon the same principle; therefore, the reference letters in Figs. 15 and 17 will apply to each machine. The end of arbor *J* is threaded to fit the inside of the cap. A bracket *K* bolted to the lathe bed, has a slot in which stud *L* is adjustable. Upon this stud is mounted lever *M* which holds the trimming blade *N* and the knurling wheel *O*. In operation, the cap is screwed onto the arbor and the lever *M* moved down until it strikes the stop *P*, this one operation sizing the cap, chamfering the end, truing up the sides and knurling the grip. These machines also are fitted with reversing clutches.

Fig. 10 illustrates the stages that the blanks pass through when being made into caps. At *A* are shown the blanks for the large caps; at *B*, the cupped blanks; and at *C*, the finished caps; *D*, *E*, and *F* show the steps in making the small caps, and at *G* and *H* are illustrated small and large finished caps of another style.

Decorating, Embossing and Filling the Tubes

If the tubes are to be decorated like those shown at *A*, Fig. 1, they are sent to the decorating department, where attractive designs are lithographed in one, two or three colors. A decorated tube has a superior appearance compared with a tube with a paper label pasted upon it, and in addition, the lettering will be plain and easily legible long after a paper label has been washed from a tube.

Some manufacturers prefer to use a tube without labels or ink-printing of any kind, and they use the embossed tubes shown at *B*, Fig. 1. While these tubes, perhaps, are not quite as attractive as lithographed ones, they are considerably cheaper, and there is no question as to their being sanitary. The embossing is done by rolling the lettering into the tube under embossing rolls.

Fig. 16 illustrates the machines for filling and closing the tubes in the filling department. The dental cream is contained in the large cylinder *A* that extends to the floor above. Pressure upon the foot treadle opens the valve in nozzle *B*. The operator slips a tube over the nozzle and with-

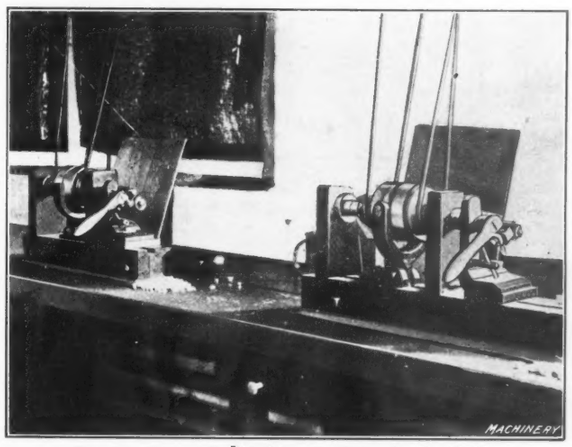


Fig. 18. Two of the Machines for Trimming Small Caps

draws it as it is quickly filled with the dentifrice, replacing it immediately with another empty tube. Another operator then takes the tubes and closes the ends, by folding in the press at the right in Fig. 16, and the completed tubes, filled with dentifrice, are ready for packing.

* * *

The influence which machinery has had on the development of agriculture is well indicated by the news of a remarkable record in plowing made on October 14 at Lafayette, Ind. Official tests were made by the Purdue University and the Indiana Agricultural College with a multiple plow consisting of fifty individual plows pulled by three traction engines. The plows were designed and made by the Oliver Plow Works, of South Bend, Ind., while the traction engines were made by the M. Rumely Co., of La Porte, Ind. By this equipment it was found possible to turn over an acre of ground in four minutes, fifteen seconds, or at the rate of about fourteen acres an hour. Feats of this kind indicate that, while agriculture is, and always must remain, the fundamental or basic human activity, the mechanical trades have made agriculture what it is today. The machine designer and the mechanic are as necessary to the farmer who uses modern methods as the latter is to them.

MILLING RADIAL TEETH IN CUTTER BLANKS—2*

By GEORGE W. BURLEY†

In the previous installment of this article, a formula was deduced for finding the depth of cut required when milling radial teeth, such as the teeth on the side of side milling cutters and the end teeth of end-mills. This formula was as follows:

$$d = R\left(1 - \frac{0.025}{\sin \phi}\right)\cos \theta \qquad (4)$$

in which the symbols denote quantities as indicated in Figs. 1 and 2, which illustrations are here reproduced from the previous installment.

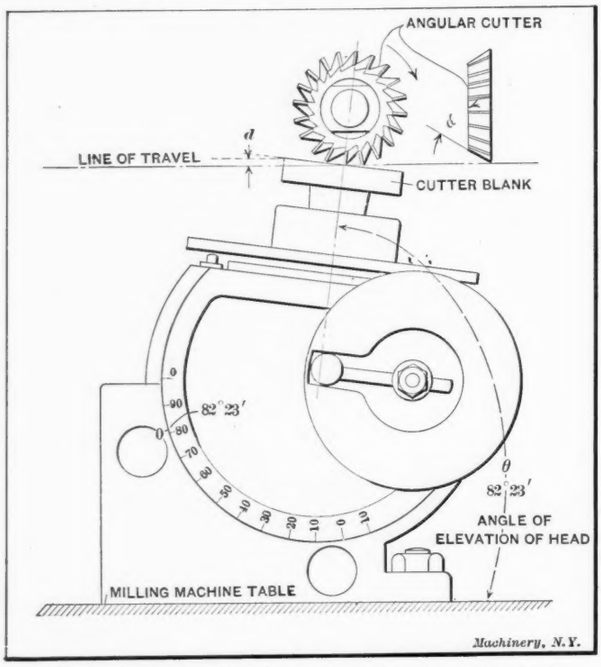


Fig. 1. Diagram for Calculating Angle of Elevation of Index-head

It is common practice, however, to leave the blanks of the cutters slightly larger than the finished cutters, in which case Formula (4) will have to be modified to take this difference in dimensions into account. The modified and exact formula is:

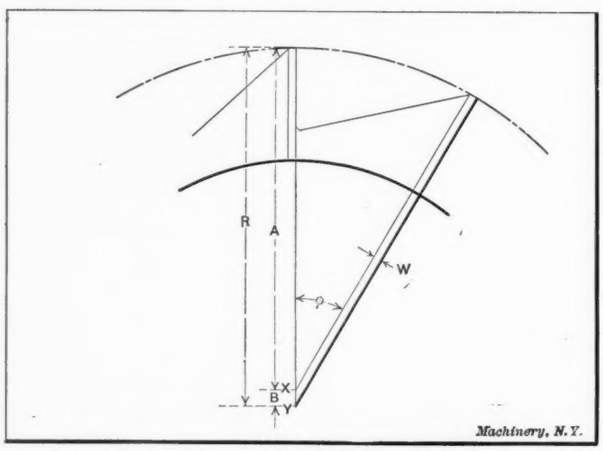


Fig. 2. Part Plan of a Side Milling Cutter, illustrating Method of Determining Width of Land, etc.

$$d = R_1\left(1 - \frac{0.025}{\sin \phi}\right)\cos \theta + x \sin \theta \qquad (5)$$

in which R_1 = the actual radius of the cutter blank, and x = one-half of the difference between the thickness of the blank and that of the finished cutter.

To illustrate the use of this expression, let us suppose that $R = 4$ inches; $N = 36$ (number of teeth); and $\alpha = 75$ degrees.

Then $\phi = \frac{360}{36} = 10$ degrees, tan $\phi = 0.1763$, and cot $\alpha = 0.2679$.

Therefore $\cos \theta = 0.1763 \times 0.2679 = 0.04723$.

Further, $\sin \phi = 0.1736$; so that $\frac{0.025}{\sin \phi} = \frac{0.025}{0.1736} = 0.144$.

Neglecting oversize, and employing Formula (4),

$$d = 4\ (1 - 0.144)\ 0.04723$$
$$= 0.1617 \text{ inch.}$$

Now let $R_1 = 4.005$ inches and $x = 0.005$ inch, these dimensions allowing for 0.010 inch oversize on the blank both in regard to the diameter and to the width. Then $\sin \theta = \sqrt{1 - \cos^2 \theta} = \sqrt{1 - 0.04723^2} = 0.9988$. Hence

$$d = 4.005\ (1 - 0.144)\ 0.04723 + (0.005 \times 0.9988)$$
$$= 0.1619 + 0.004994$$
$$= 0.166894$$
$$= 0.1669 \text{ inch aproximately.}$$

It will be noticed that, in the case chosen, sin θ is almost equal to unity. This is true for practically every case, so that instead of Formula (5) we can use, with sufficient accuracy for all practical purposes, the following formula:

$$d = R_1\left(1 - \frac{0.025}{\sin \phi}\right)\cos \theta + x \qquad (6)$$

* * *

THE SELECTION OF DIRECT-CURRENT MOTORS FOR FACTORY USE*

The prospective purchaser should ascertain accurately the desired speed or speeds of the machine to be driven, and the maximum horsepower as well as the average horsepower required to do the work. The speed or speeds of the driven machine may be ascertained by tests conducted with an experimental motor, or from data furnished by the builder of the machine, where such information is available. Often the motor drive is to replace a steam drive, or individual motor drives are to replace an existing motor-driven group drive, in which cases the speeds are easily determined.

Horsepower Required

The horsepower required to do the work should be determined as accurately as possible. The purchaser may rent an experimental motor and ascertain the power required, which is probably the most satisfactory way to solve the problem. The group drive generally requires that this testing be done, as the amount of power required under actual conditions for a group of machines of different kinds and sizes is problematical, and the information cannot be obtained from the machine manufacturers as can often be done in the case of an individually driven machine. It should be remembered in this connection that from the input to the test motor as measured with a wattmeter, or with a voltmeter and ammeter, should be subtracted the test-motor losses, as the motor to be purchased is rated on horsepower output or brake-horsepower. Money spent in the accurate determination of the amount of power required is wisely expended—a fact often overlooked by the factory manager.

Machine-tool builders, motor manufacturers, and central stations are often called upon to supply the information as to how large a motor should be. Without accurate data, the machine-tool builder often overestimates the horsepower required for driving his tools, in order to be on the safe side, with the result that the motors run at one-quarter to one-half load day in and day out, at greatly reduced efficiency. The electrical losses, together with interest and depreciation on the unnecessary extra investment may amount to a considerable sum in a large installation. It certainly behooves the machine-tool builder to have on hand (and, of course, many of them do) accurate data required from carefully conducted tests, covering the performance of his motor-driven machines under all conditions of load and speed.

The motor manufacturer often has in his own establish-

* With Data Sheet Supplement.
† Address: University of Sheffield, Sheffield, England.

* Abstract of an article by Earle D. Jackson in the *Engineering Magazine*, September, 1911.

ment individual machine-tool drives and group drives similar to those of the prospective purchaser, in which event he can supply the necessary information as to the size of the motor. Many up-to-date central stations also have a vast amount of data on power required for different motor drives, derived from actual tests under working conditions, which are always available to a prospective power consumer.

The piece-worker requires a relatively larger motor for the same tool than does the operator working by the day. In the former case, heavy cuts at the higher speeds will be the rule, together with quicker starting and more continuous running of the motor, as the piece-worker crowds his machine to the limit, and must be provided with ample motor capacity. Nothing is more discouraging to a workman than to find out that the motor will not perform all the work he requires of it, or is continually giving trouble.

Having determined the speeds of the driven machines and the horsepower required to do the work under all conditions, a knowledge of the various types of direct-current motors is the next essential in order that the motor may be selected which will fulfill the conditions required of it in the most acceptable manner.

Types of Motors for Different Requirements

The general classification of direct-current motors now included in the standard product of nearly all motor manufacturers is as follows:

Approximately constant speed, no load to full load	Shunt motor. Shunt-commutating pole motor.
Semi-constant speed, no load to full load	Compound motor.
Adjustable speed, remaining approximately constant for one adjustment, no load to full load	Shunt motor, with adjustable field resistance. Shunt-commutating pole motor with adjustable field resistance.
Adjustable speed, semi-constant for one adjustment, no load to full load	Compound motor, with adjustable shunt field resistance.
Varying speed, varying with the load	Series motor. Series-commutating pole motor.

Open or Enclosed Motors

The question whether to employ the open or enclosed motor often arises. The metal covers of closed motors reduce the efficiency and capacity of the motor by preventing free circulation of air around the active elements of the motor. Working conditions will usually decide whether it is possible to use the open motor, which is, of course, the desirable practice, or whether the presence of excessive dust makes it necessary to enclose the moving parts of the motor partially or completely. The partially or semi-enclosed motor should not be placed in a concealed position for the reason that it is then certain to be neglected in an ordinary factory. The perforated covers and wire screens will close up by dust and dirt, and as the result the semi-enclosed motor becomes virtually a totally enclosed motor with a semi-enclosed rating and consequent trouble.

General Considerations

Vertical motors are made in the various sizes and are only to be recommended when the nature of the drive makes it apparent that they possess great advantages over the standard or horizontal type, as vertical motors are troublesome to keep in running order and require greater attention. They are not generally kept in stock by local dealers, and the motor, as well as repair parts, must be replaced from the factory stock at the risk of the usual delay in shipment.

Manufacturers' standard sizes and speeds of motors should be chosen wherever possible, in preference to motors of special sizes and speeds, as prices, time of delivery, and general performance of the former will be found to be more favorable than those of special design. In many cases, it will be found impossible to select from the standard sizes and speeds of a single motor manufacturer only, all the motors which are required, and in this case there is no valid reason why the order should not be divided up and the motors purchased of the builders whose standard product meets the required conditions.

The direct-current voltage now practically standardized for factory use is 220 volts. This voltage is both economically and operatively superior for direct-current motor systems to that of 110 volts sometimes employed.

Types of Drives

Having determined the horsepower and selected the type or types of direct-current motors desired, the best means to employ in driving the machines is the next problem that is confronted. In considering a belt drive, a greater pulley reduction than 5 to 1 is not to be recommended. Idlers to increase the arc of contact, or countershafts between the motor and the driven machine to reduce the initial speed of the driver, are doubtful expedients, unless the amount of power used is very small. It is an easy matter to design a belt drive of this kind in which 20 to 30 per cent of the power of the motor is wasted between the motor and the driven machine.

Direct-connected drives, gear drives, and silent chains constitute a list of positive drives from which it should be possible to select a satisfactory method of driving a machine from a motor, in which safety, reliablity, and economy of operation are all present. The direct-connected drive is the ideal drive, as it eliminates all intermediate power-absorbing apparatus. In a great many cases, however, the use of the direct-connected drive necessitates the employment of a special motor. It is unfortunate, in this respect, that machine-tool builders and motor manufacturers often disregard each other when it comes to the selection of standard speeds for their respective machines, although they are collaborating more than they did formerly. The silent chain as a means of driving a machine is coming into wider use. The early types of silent chains were expensive, rapidly depreciated, and in many installations were far from being "silent." In point of efficiency, the silent-chain drive stands next to the direct-connected drive. The main objection to the gear drive is its excessive noise, but this may be overcome to a large degree by the use of a rawhide pinion.

Specifications

Specifications should be drawn which state in detail the number of motors required, the horsepower of each motor, the desired motor speed or speeds, together with the speed or speeds of the corresponding driven machine, and the name or description of the machine, giving the number of hours of its probable use per day; whether the motor is to be of the open, semi-enclosed, or enclosed type; the line voltage; details of the motor drive, including pulleys, gears, chains and sprockets, of both driver and driven machine; and whether the motor foundations are to be included in the contract price. Specifications should be submitted to at least three reputable motor manufacturers for quotations, giving cost complete in the case of each separate motor, weights and mechanical sizes of motors offered, efficiencies at one-quarter, one-half, three-quarters, and full loads, for all ranges of speed called for, speed regulation from no load to full load, commutation at all loads and speeds, temperature rise, overload capacity, times of delivery, and description of all starting and field or other rheostats to be furnished, as well as complete description of each motor. Each one of the foregoing items should be known, if intelligent comparison and selection are to be made. The specifications may also call for a test of each motor purchased, to be made by the purchaser or his engineer after the motors are in place and before final acceptance, to demonstrate whether or not all of the required conditions have been fulfilled.

The investment in a set of inexpensive but reliable electrical measuring instruments is to be highly recommended in connection with a motor drive. For a small installation, the set should include a portable voltmeter, ammeter, and wattmeter. For a large installation, a considerable investment is sometimes warranted. Thus on important machines, graphic wattmeters can be installed, showing at any time of day the amount of power used. These instruments, moreover, can be moved from place to place, until every motor in the shop has been included, thus acquiring valuable data for shop records. This is especially valuable immediately after a drive is installed as a means of ascertaining whether or not the motor of proper size and characteristics has been selected.

DESIGNING A HYDRAULIC ACCUMULATOR

By W. E. MOREY*

When designing a hydraulic accumulator intended to serve a given number of presses, the factors given in the following must be taken into account. Some of them, as will be shown later, may be disregarded in most cases, because they are of small importance. The factors are:

1. Normal requirements of all presses, measured in gallons of water per minute.
2. Pressure to be maintained in pipe lines.
3. Capacity of pumping plant in gallons per minute.
4. Friction losses in pipe lines.
5. Friction losses in moving parts.
6. Available space for the erection of the accumulator.
7. Inertia of moving parts.
8. Strength of materials used.
9. Required excess capacity, to provide for possible expansion in business.

The last factor depends on whether the possible expansion is likely to take place in the near future, and whether the increase would not be better taken care of by building another accumulator when required. In the present case we will assume that we are to build the accumulator large enough for present needs, and will let the future take care of itself.

It will be necessary to assume certain of the factors mentioned, and work out the design accordingly. Assume a working pressure of 1500 pounds per square inch for all the presses. The presses to be served are as follows: One press of 600 tons capacity, 24-inch stroke, making two strokes per minute; one press of 300 tons capacity, 36-inch stroke, making three strokes per minute; two presses of 100 tons capacity each, 15-inch stroke, making four strokes per minute; three presses of 50 tons capacity each, 12-inch stroke, making four strokes per minute.

By assuming the capacity of the presses, and basing the calculations on this assumption, the internal friction losses may be neglected, because it is not necessary that the presses should be of the exact capacity assumed.

The amount of water required by the presses, in gallons per minute, is calculated by the following formulas:

$$A = \frac{C \times 2000}{P} \qquad (1)$$

in which A = area of ram in square inches,
C = capacity of press in tons,
P = pressure of water in pounds per square inch.

$$G = \frac{N \times n \times A \times S}{231} \qquad (2)$$

in which G = gallons of water per minute,
N = number of presses of any given size,
n = number of strokes per minute,
S = length of stroke in inches,
A = area of ram in square inches.

Substituting Equation (1) in (2):

$$G = \frac{N \times n \times C \times 2000 \times S}{P \times 231} \qquad (3)$$

Substituting the numerical values in Equation (3), we have, for the 600-ton press,

$$G = \frac{1 \times 2 \times 600 \times 2000 \times 24}{1500 \times 231} = 166.2 \text{ gallons per minute.}$$

For the 300-ton press we require 187.0 gallons per minute, for the 100-ton presses, 69.3 gallons per minute, and for the 50-ton presses, 41.5 gallons per minute. The total amount of water required thus is 464 gallons per minute, or say, in round numbers, 465 gallons.

In many hydraulic plants, if not in all, two lines of pipes are used, one for low-pressure, say 300 pounds per square inch, and one for high-pressure, say 1500 pounds per square inch, with such an arrangement of valves at the presses as will permit the rams to be moved as far as possible with the low-pressure or "cheap" water, the heavy pressure being thrown in only to complete the stroke. As in the present instance the design of the accumulator only is considered, we will assume only one set of pipes.

* Address: 523 Railway Exchange, Chicago, Ill.

The capacity of the pumps is assumed to be 350 gallons per minute. We have found, however, that the normal capacity of all the presses is 465 gallons per minute. Owing to the fact that the presses are very rarely all in operation at the same time, and also on account of the fact that it is customary to shorten the strokes whenever the work permits it, it is safe to design the accumulator with a capacity of 115

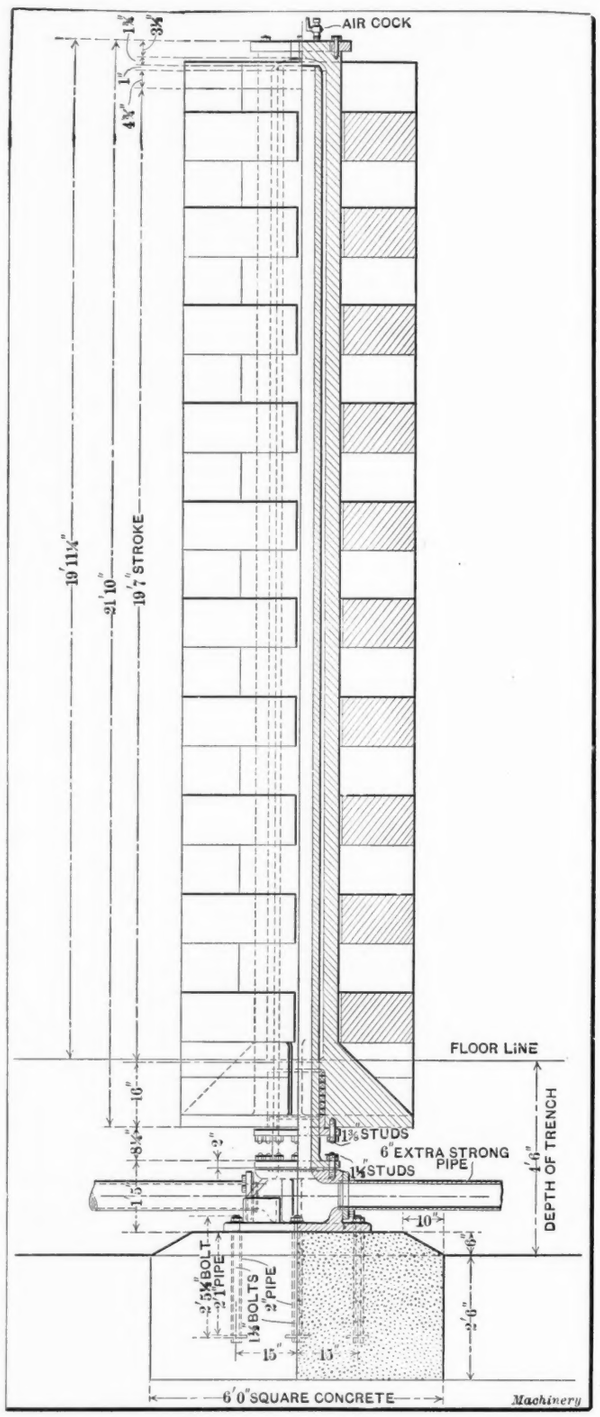


Fig. 1. General View of Hydraulic Accumulator

gallons per minute, as this will provide a sufficient margin for all conditions.

Having determined the capacity of the accumulator in gallons, we must now ascertain the available head room where the accumulator is to be located. In this way we can determine the stroke and the resultant diameter. It is better to use as long a stroke as possible, with a ram of small diameter, rather than a short stroke and large diameter, because the weight on the accumulator necessary to produce a given

pressure varies as the square of the ram diameter. In the present case it is not desirable to build a tower above the roof to accommodate the accumulator, and we find that from the top of the foundation to the top of the accumulator at the extreme stroke, the distance is 44 feet. An allowance of 5 feet is made between the top of the weights and the roof, to make it possible for workmen to go up on the top without danger, when the accumulator is in operation. The top of the foundation is placed 4 feet below the power-house floor. This brings the pipes low enough to be safe from frost when running directly from the pumps through the accumulator to the main.

The depth of the base casting is determined largely by the diameter of the pipe flanges which secure the inlet and outlet pipes to it. These pipes are 6-inch extra-strong steel pipes, with an outside diameter of 6⅝ inches and an inside diameter of 5¾ inches. The studs through the pipe flanges must be strong enough to resist a pressure of 1500 pounds per square inch on the inner cross-sectional area of the pipe. Owing

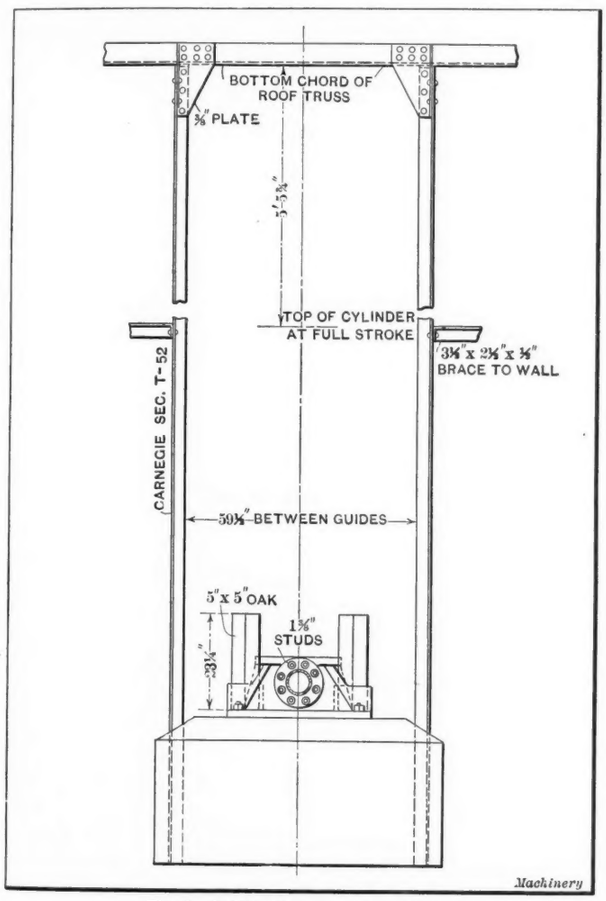


Fig. 2. Guiding Frame of Accumulator

to the stresses brought to bear upon the studs by tightening up the nuts, it is not advisable to figure on an allowable stress in the studs of more than 5000 pounds per square inch at the root of the thread. By the formula,

$$a = \frac{d^2 \times \pi \times P}{4 \times T} \qquad (4)$$

we find the total stud area required. In the formula given:

d = inside diameter of pipe = 5¾ inches,
P = pressure of water = 1500 pounds per square inch,
T = allowable stress in studs = 5000 pounds per square inch,
a = total area of studs at root of thread.

Hence,

$$\frac{5.75^2 \times 3.14 \times 1500}{4 \times 5000} = 7.79 \text{ square inches.}$$

If we assume that we use eight studs, we will find that the nearest stud diameter will be 1⅜ inch with an area of 1.06 square inch at the root of the thread. The stud circle must be 9¼ inches in diameter in order to permit ample room on the outside of the 6-inch pipe to turn the hexagon nuts. The outside diameter of the flange we may make 12 inches. The base portion of the casting should have a thickness of, say, 2 inches; ½ inch is allowed at top and bottom of the flange, making the total height 15 inches. Approximately three feet should be allowed for the gland, the clearance under the gland, and the clearance at the top of the cylinder. Hence, 4 feet 3 inches should be subtracted from the total available space of 44 feet. This leaves us 39 feet 9 inches, which will be approximately twice the stroke of the accumulator, the stroke thus being assumed, for preliminary purposes, to be 19 feet 11 inches. As there are 231 cubic inches in one gallon, and the stroke is 239 inches, the diameter of the ram for an accumulator of 115 gallons capacity is found as follows:

$$d^2 = \frac{115 \times 231}{239 \times 0.7854} = 141.5, \text{ and } d = 11.9 \text{ inches}$$

The diameter, then, will be assumed to be 12 inches, and the stroke will be made to suit this diameter.

The next step is to determine the inside diameter of the ram which is calculated from the following formula:

$$P \times (12 - 2t) = S \times 2t$$

in which P = pressure in pounds per square inch, as before,
t = thickness of wall in inches,
S = allowable working stress of cast iron = 3000 pounds per square inch.

Thus we have:

$$1500 \times (12 - 2t) = 3000 \times 2t$$
$$t = 2 \text{ inches.}$$

The ram must be bolted to the base casting strongly enough to resist an upward pressure of 1500 pounds per square inch on the area of an 8-inch circle. To find the bolts required, Formula 4 is used:

$$a = \frac{d^2 \times \pi \times P}{4 \times T}$$

in which d = inside diameter of ram, the notation otherwise being as before.

Hence,

$$a = \frac{64 \times 3.14 \times 1500}{4 \times 5000} = 15.1 \text{ square inches.}$$

It will be found that twelve studs, 1½ inch in diameter, will be required, as the area at the root of the thread of a 1½-inch stud is 1.295 square inch. In order to be able to use a good-sized fillet at the flange, the stud circle is made 17 inches in diameter, and the outside diameter of the flange 21 inches. The thickness of the flange will be made 2 inches in order to be uniform with the flange on the base casting.

From the data so far obtained we can now complete the drawing of the base casting, being careful to nicely round the core so as to offer the least possible resistance to the passage of the water. Care is also taken to make the casting of uniform section, as far as possible, so that the shrinkage will be as uniform as possible, and cracking from internal strains avoided. The joint between the ram and the base is made by cutting a circular groove in the base casting and partly filling it with lead, well peened in and faced. An annular projection on the bottom of the ram bears on this lead ring. In addition, a sheet rubber gasket is used inside of the lead joint, extending to the 8-inch bore. The pipe joints on the sides are indicated in Fig. 3, where the pipe flanges are also shown.

The next step is to design the gland and the lower end of the cylinder. We must first determine the lowest position of the cylinder, by allowing room for packing it when the gland is resting on the ram studs. A space of 8¼ inches between the bottom of the cylinder and the top of the ram flange, with a gland as shown in detail in Fig. 3, will allow about 2 inches space for putting in the packing. The cylinder is supported in this position by four oak blocks, 5 by 5 inches, which fit into pockets in the casting as indicated in Fig. 2. The gland studs are of such length that the nuts can be started when the gland is entered ½ inch into the cylinder. The packing is to be 1-inch square braided flax, soaked in tallow, and the length of the packing chamber, when the gland is up to within ½ inch of the cylinder flange, is to be about equal to the diameter of the ram, or 12 inches.

The size and number of gland studs are calculated by the following formula:

$$a = \frac{(d_1^2 - d_2^2)\pi \times P}{4 \times T}$$

in which d_1 = outer diameter of gland = 14 inches,
d_2 = inner diameter of gland = 12 inches,
P = pressure of water = 1500 pounds per square inch,
a = total stud area at root of threads,
T = allowable stress in studs = 5000 pounds per square inch.

Hence,

$$a = \frac{(196 - 144)3.14 \times 1500}{4 \times 5000} = 12.25 \text{ square inches.}$$

Assuming that twelve studs will be used, we find that studs of 1⅜-inch diameter, having an area at the root of the thread of 1.06 square inch, will be required. The stud circle is made 18 inches in diameter, in order to get ample room to turn the nuts. The flange is made 21 inches in diameter.

The inner diameter of the cylinder will be made 14 inches, as it is not to be bored and it is necessary that it be large enough to insure its not coming into contact with the ram. The thickness of the metal is calculated from the following formula:

$$t = \frac{P \times D}{2S}$$

in which t = thickness of cylinder,
P = pressure of water, as before,
D = internal diameter of cylinder = 14 inches,
S = allowable stress in metal = 3000 pounds per square inch.

Hence,

$$t = \frac{1500 \times 14}{2 \times 3000} = 3\tfrac{1}{2} \text{ inches.}$$

The length of the ram and the length of the cylinder must now be definitely determined. In order to have a capacity of 115 gallons, we find, as indicated below, that the cylinder must move 19 feet 7 inches.

d = diameter of ram = 12 inches.

$$\frac{115 \times 231}{d^2 \times 0.7854 \times 12} = \text{stroke in feet} = 19.58 \text{ feet.}$$

It is, of course, necessary to allow a margin of safety in the length of the ram, so that the bored portion of the cylinder above the packing will not pass the end of the ram. In Fig. 1 it will be noted that at the extreme stroke, or rather at a normal stroke of 19 feet 7 inches, this portion comes within 4¾ inches of the end of the straight part of the ram. This gives 22 feet 3 inches for the length of the ram including a 60-degree chamfer at the top, 1 inch in length, for facilitating assembling, but not including the annular projection at the bottom.

An automatic throttling arrangement, connected by cable to a butterfly valve in the steam pipe of the pump, is located at such a point that it becomes operative when the cylinder reaches this point. As a further protection, two ¼-inch holes are drilled through the ram just above the lower line of the packing when the cylinder is at the extreme stroke. These holes are 1 inch apart vertically. By this means instant and audible, as well as forcible, notice is given to any one in the engine room if the accumulator exceeds its proper stroke.

The length of the cylinder may now be determined. A clearance of 1¾ inch is allowed between the top of the ram and the inside of the cylinder head. In order that the stresses in the metal at the top may be uniform with those in the sides, the inner radius is made equal to the inside diameter of the cylindrical portion, or 14 inches. The curved head is then joined to the sides by a fillet of 2-inch radius. The thickness of the head is the same as that of the sides, or 3½ inches, thus making the total length of the cylinder 21 feet 10 inches, as shown in Fig. 3.

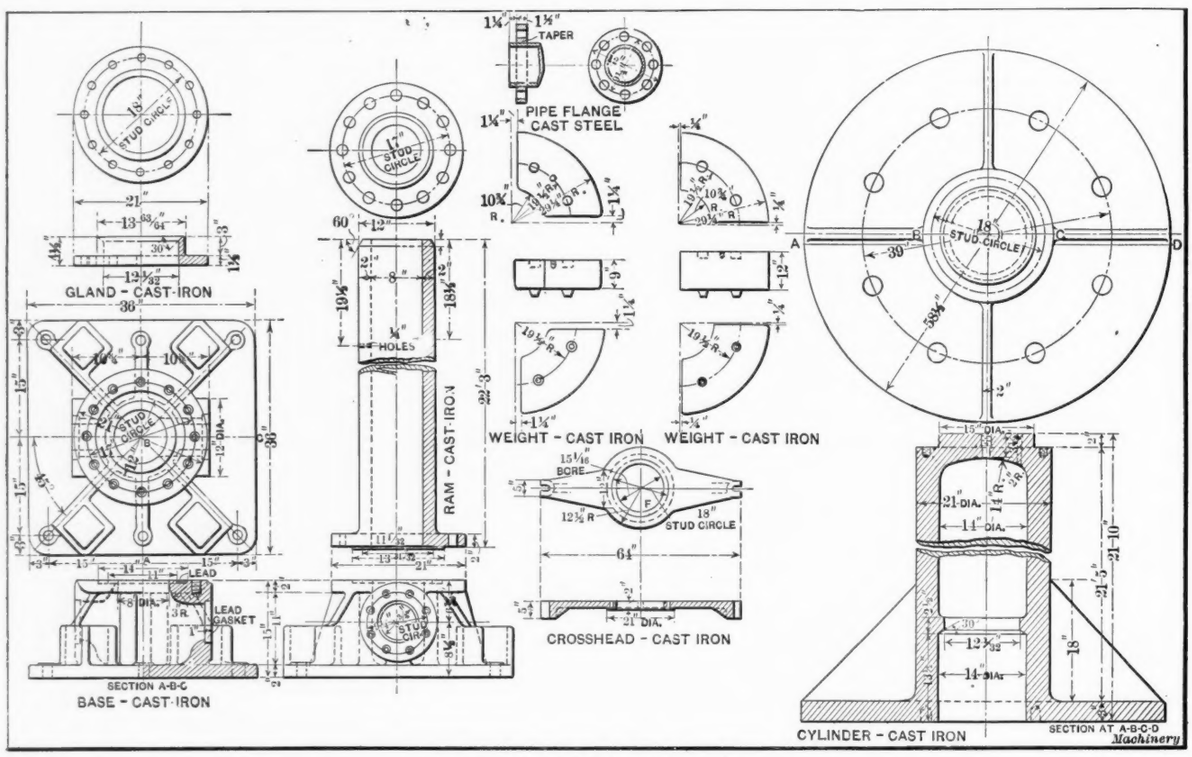


Fig. 3. Details of Hydraulic Accumulator

It is now possible to calculate approximately the weight of the cylinder and find how much additional weight is necessary to produce a pressure of 1500 pounds per square inch of ram area. The total weight required, neglecting the friction of the packing, is found as follows:

$$W = \frac{P \times d^2 \times \pi}{4}$$

in which W = total weight required for the accumulator,
P = pressure of water, as before,
d = diameter of ram = 12 inches.

Hence,

$W = 1500 \times 144 \times 0.7854 = 169{,}600$ pounds, approximately.

The weight of the cylinder, as shown in Fig. 3, without the lower flange and ribs, is calculated to be 13,200 pounds, which leaves a balance of 156,400 pounds to be provided for by means of weights of cast iron, made in the form of segments, each of

which is one-quarter of a ring. The inner diameter of these segments is made ½ inch larger than the outside diameter of the cylinder, or 21½ inches. Assuming that the total height of the weights, including the 3-inch flange at the bottom of the cylinder, may be 21 feet 6 inches, we find the outside diameter of the weights and the cylinder flange by the following formula:

$$W = (D^2 - d^2)\ 0.7854 \times 0.26 \times H$$

in which D = outside diameter of weights in inches,
d = inside diameter of weights = 21.5 inches,
H = height of weights = 258 inches.

The factor 0.26 is the weight in pounds of one cubic inch of cast iron. Hence,

$156{,}400 = (D^2 - 21.5^2)\ \ 0.7854 \times 0.26 \times 258$, and $D = 58.5$ inches.

In order to strengthen the lower flange of the cylinder, the casting is made with four ribs 2 inches thick and extending 18 inches up the sides. This makes it necessary to make the two lower rows of weights of such size that they will fit between the ribs. It will be seen in Fig. 3 that the cylinder flange has a series of holes spaced equally on a 39-inch diameter circle. Into these holes, lugs on the bottom side of the lower weights fit. The tops of the weights have similar holes so that the whole mass is securely locked together. The segments "break joints" after the first two rows are laid, as indicated in Fig. 1. Each weight is tapped for a 1-inch eye-bolt, which is to be located above its center of gravity for handling purposes.

To guide the accumulator, a crosshead of such length that the guides will clear the weights is bolted to the top of the cylinder. The guides are formed of Carnegie steel T-sections, T-52, which are connected by gussets to the lower chord of the roof truss and securely braced to an adjacent brick wall. The lower ends are imbedded in the concrete foundation, as shown in Fig. 2.

In the center of the cylinder head is a hole which is left in the casting as a support for the core. The hole is afterwards tapped for a 2-inch pipe plug. By using an eye-bolt with pipe threads, this can be used for raising the cylinder into position. To let out the air when necessary, a valve is provided in the cylinder head.

In designing the foundation we must take into account the bearing value of the concrete and the bearing value of the soil. The total weight to be supported is approximately ninety tons, and as concrete composed of one part of Portland cement, two parts of sand, and five parts of broken stone, can carry from twelve to fifteen tons per square foot, an area of 9 square feet under the base casting is more than sufficient. The soil upon which the foundation is to rest, we will assume, consists of sand well cemented and able to carry a pressure of from four to six tons per square foot. It might, therefore, be allowable to use a base 5 feet square, but as the accumulator is so high that it would readily be thrown out of plumb by a slight settling, the base should preferably be made 6 feet square. The bolts are set in pipes to allow for slight variations.

No account has been taken of the inertia of the falling accumulator with regard to its effect on the strength of the parts. The reason for this is that the pipe lines are provided with shock valves at various points. These valves consist of plungers which are moved in stuffing boxes to relieve any excess of pressure. They are controlled by springs whose strength is proportioned with reference to the normal pressure in the lines.

* * *

The world's speed record for a long-distance train is said to be the 82 hours 15 minute record made by a special train from Seattle to New York City, a distance of 3178 miles. This record was recently made by a train laden with two million dollars' worth of silk, over the Great Northern, the Chicago, Burlington & Quincy, and the New York Central lines. This is an average speed of more than 38.5 miles per hour for the entire distance across the continent. Considering the fact that two great mountain ranges were crossed, and that frequent changes of engines and train crew were necessary, the time made is remarkable. The best previous record by rail between the Atlantic and Pacific coasts was 97 hours 40 minutes.

TASK WORK—THE BASIS OF PROPER MANAGEMENT*†

About fifteen years ago, the financiers of this country realized that in many cases, at least, the larger factories were making a greater percentage of profit than the smaller ones, and they conceived the idea of uniting the smaller ones under one system of management. By this move the small factories were placed on a better financial standing, and the financial or business expense was reduced. In this way they also reduced competition and decreased the cost of selling. Business prospered rapidly, and the illustrated magazines were filled with pictures of the "captains of industry" who had engineered these combinations; it was freely predicted that the economies obtained were so great that it would only be a question of time before Europe would be flooded with American goods.

The formation of "trusts" in manufacturing, and of great "systems" in railroading went on at a rapid rate for some years. The economies produced by these methods, and the elimination of competition, enabled many combinations to pay dividends on stock that represented little or no value. While the internal trade grew at an astounding rate, the American invasion of Europe did not materialize, and it was not long before complaints were heard of the "increasing inefficiency of labor." Wages began to rise, but the output of the workmen did not rise correspondingly. The financier had undoubtedly effected economies in the portions of the business directly under his control, but he had not succeeded in producing a similar effect on those with which he did not come in direct contact.

As a matter of fact, while the financier had been forming his great combinations with the effect of upholding prices, the workmen had gone him one better. By their unions, not only had they upheld the price of their labor, but in many cases markedly increased it, without rendering any more service than formerly; the employers, in many cases, say less. As cooperation among employers to uphold the price of their product had been so successful, it is scarcely to be wondered at that the workmen should adopt the same tactics.

On this subject Adam Smith, in his famous book, "An Inquiry Into the Nature and Causes of the Wealth of Nations," nearly one hundred and forty years ago, wrote as follows: "Our merchants and master manufacturers complain much of the bad effects of high wages in raising the price and thereby lessening the sale of goods at home and abroad. They say nothing of the bad effects of high profits. They are silent with regard to the pernicious effect of their own gains. They complain only of those of other people."

This statement made so long ago is just as applicable to the conditions of today, and admonishes us in approaching our problem to do so with an open mind and not from a partisan standpoint, for a solution cannot be permanent if it benefits one class exclusively. With regard to the mention made of the *increasing* efficiency of labor, it must be said that while the manager cannot be held responsible for the inefficiency he finds, he is responsible if he allows it to increase. It therefore seems that this problem is one of management, and if the methods now generally in vogue do not accomplish the desired results, they must be modified.

The Task Idea

In studying a problem, it is best to consider the simplest form in which that problem can be presented. A good example for our purpose is to study the methods by which a child is taught to perform a simple operation. The invariable method is to show the child, as clearly as possible, what is wanted, and then to set a task for it to accomplish. The accomplishment of the task is rendered much easier for the child if a suitable reward is offered. As a matter of fact, the setting of tasks and rewarding the performance is the standard method of teaching and training children. The inducement to perform a task is always some form of benefit or reward. It may not always be as immediate as the lump of sugar that the child gets, but the work is still done for some reward,

* Abstract of a paper read by Mr. H. L. Gantt before the convention of the National Machine Tool Builders' Association, October, 1911.

† See MACHINERY, April, 1907, engineering edition, "The Utilization of Labor."

immediate or prospective. Further, it is acknowledged that to work at a task which we recognize as being within our power to accomplish, without over-exerting ourselves, is less tiring and more pleasant than to work along at the same rate with no special goal ahead.

The idea of setting for each worker a task with a bonus for the accomplishment seems, therefore, to be in accord with human nature, and hence is the proper foundation of a system of management. Our problem, then, is to find out how to set a proper task and what the reward should be. The ideal industrial community would be one in which every member had his proper daily task and received a corresponding reward. This is what scientific management in its highest development aims to accomplish, for it aims to assign to all a definite task each day, and to give to each individual such a reward as will make his task not only acceptable, but agreeable and pleasant.

The greatest obstacles to the introduction of these methods have not in the past come from workmen, but from foremen and others in more or less authority. Those objecting have, as a rule, either not understood the principles of the new methods, or felt their inability to hold their jobs if they were asked to perform their work in accordance with the high standards set. The new system bears hardest on those who hold their jobs by "pull" or "bluff," and from them comes the greatest opposition. In fact, there is only one class that opposes the new methods more strongly, and that is the class that uses official positions for private gain. Such people will often commit serious crimes in an attempt to prevent the exposure of their irregularities. No firm should, therefore, undertake the installation of these methods unless there is an avowed purpose to eliminate all kinds of graft and special privileges.

Schedules as Tasks

The task idea is really so common that we do not recognize it. Every railroad schedule consists of a series of tasks, and in the manufacture of such articles as sewing machines, typewriters and locomotives, the task idea is illustrated by the schedule according to which various parts are started on their way through the different departments, and day by day make such progress that they will reach the assembling or erecting shop at the proper time to complete a machine without delay. In the case of locomotives, in particular, the task idea is emphasized by the date of shipment—set often months ahead. When the shipping date of a locomotive has been set, the time when every piece must start on its course through the shop is also determined. Inasmuch as this work has been done over and over again, all the principal men in the shop know by heart the schedule of the parts with which they are concerned. When the work is of a miscellaneous character, however, the task of having each part pass through the proper sequence of operations, and arrive at the erecting shop in the order wanted, is not so easy. The inability to get miscellaneous work through the shop on time is often the source of as much expense as is inefficient work on the part of the operator.

In a small shop, one capable man can often so plan even miscellaneous work, and keep track of it in his head, that but little expense is incurred from delays, but in the large shops and in plants consisting of several shops, such a thing is impossible, and the larger the shop, the greater the loss arising from this source; hence, the greatest and most important task to be performed in any works, and one for which the management is solely responsible, is to get the work through on time and without interference.

To go into the details of how such a task is performed would be impossible in this brief account. Suffice it to say, however, that when a start has been made, and each foreman receives each day a list of jobs that must be done that day, the general efficiency of the works is much increased, even though nothing definite has been done to increase the efficiency of the individual workman. Such an order of work is a great assistance to the foreman, and its usefulness increases rapidly if the work is so planned as to avoid interference, and if all materials and appliances are ready for each workman in advance. The efficiency of the individual naturally increases with the general efficiency, and unless the inefficiency of the individual is very flagrant, it is far better to solve the general problem first and to take up the efficiency of the individual workman later. When the large problem is solved, every step in advance made by the individual stands for all it is worth, which is not always the case when work is done in wrong sequence or by inferior methods.

Having thus solved the great problem of scheduling and routing each part through the works, we come to what must be considered the real problem—that of setting a task for the workman. Indeed, it is only in cases where the number of routes is small and the sequence of operations fixed that proper tasks can be set for the workmen before the solution of the general problem.

To send a clerk into the shop with a stop-watch to time workmen and set rates or tasks, naturally arouses the opposition of the workmen, and while, no doubt, it has been possible in many cases to get out more work by so doing, its effect on the industrial conditions of the country at large have been decidedly detrimental. The working of tasks should not be a hardship, but a pleasure, if they are properly set and adequately rewarded. Before task setting can be carried on satisfactorily, the workman must be convinced that he is not approached by a scheme for driving, but by one by which he will be benefited.

Preparation for Task Setting

Among the steps taken before attempting to set a task are: getting all machines and appliances in proper order; establishing a tool-room with suitable tools for the work; arranging to supply the workman with material as required; and planning work so that one job will seldom have to be stopped to make way for another. In other words, the conditions should be so arranged that the workman can work to best advantage. This consideration includes proper ventilation and a comfortable temperature, which alone will materially increase his output, as petty annoyances of any kind reduce efficiency.

If the work requires mechanical skill, the problem should be studied by the most capable mechanic available and specific instructions given, showing the best way to do the work and the time needed when done in that way. If necessary, and it usually is, the task setter should now turn instructor and show the workman how to do the work. If the task is set in this manner by a man in whose ability and honesty the workman has confidence, there is little difficulty in getting a task-work system started, provided a proper bonus is offered.

The proper bonus is one that will make the workman feel that he is fully compensated for the extra exertion. Hence the bonus depends upon the severity of the work. It varies from 20 to 50 per cent of the day rate. Task-work does not necessarily mean more severe work, but more continuous work under more favorable conditions. To attempt to set a task so severe that very few people can perform it, would be of no advantage from any standpoint, for few will continue to strive for a reward which they cannot reach.

Performing the Task

Having set a task, the responsibility for its performance does not rest upon the workman alone, but must be shared by the instructor, who must see that the conditions under which the task was set are maintained. Therefore, every case of lost bonus must be investigated and the reason determined. Such investigations, in the case of men who know how to perform the task as required, usually lead to the discovery of slightly defective material or machines, imperfect tools, or other conditions which might reduce the output by 10 or 15 per cent, but which would not be noticed unless a special search were made for them. The setting of a task thus imposes an obligation on the management, with the invariable result of a better and cheaper product.

Task-work in a Machine Shop

The setting of a task in the machine shop today is quite different from what it was ten years ago. At that time, machine operations took a relatively long time, and the time between each operation was of much less importance. Today, machine operations are, as a rule, performed three times as fast, so that the time for changing jobs has relatively become

three times as important, and to plan the work so that there will be no lost time in changing from one job to another has become a more important factor. For each machine tool operated today, nearly three times as much work must be planned. The ratio between the number of men actually engaged on mechanical work and those engaged in supervising or in preparing work must also necessarily be quite different from what it was before the advent of high-speed steel.

As has already been said, it is essential that the conditions under which the tasks have been set should be maintained permanently. Failure to maintain the conditions will bring hardship to the workman, and no one should, therefore, undertake the introduction of task-work unless he is prepared to maintain the conditions of his shop at a high standard; otherwise dissatisfaction is sure to spring up.

The sum of the tasks which can be performed by the individuals of a shop is the shop task, and the sum of the tasks of the shops is the factory task. Every foreman who succeeds in the accomplishment of his shop task should be properly rewarded. In this way, the foreman and the workman are brought together by a mutual interest, and a spirit of cooperation develops. Under such a scheme as described above, it is evident that there will also be a decided increase in profits. Having satisfied ourselves that these methods will result in an increased production of wealth, we now ask what effect this increase of wealth will have on the industrial conditions of the country.

Effect of Scientific Management on General Prosperity

General prosperity is not promoted by the accumulation of wealth in the hands of one class, but by the interchange of commodities. Unless, therefore, these methods help this interchange, the community will be but slightly benefited. Individual concerns will undoubtedly be largely benefited at first, but it is doubtful if this benefit will continue unless the public at large is also benefited. Adam Smith said, over a century ago, that prosperity was greatest when profits were small and business, or interchange, large. We know this to be a fact, and unless some of the economies of these methods are shared with the public in the shape of reduced prices, thus making possible an increase of business, it is extremely doubtful if these methods will permanently improve our industrial conditions. It should be constantly kept in mind that the individual cannot continue to prosper indefinitely unless the country at large prospers also.

Scientific management has been likened to labor saving machinery and the parallel is very close. Labor saving machinery has greatly increased wealth and improved the conditions of civilized man, but with the increase of wealth have come greater relative differences between rich and poor, and it is doubtful if the relations between employer and employe are any better today than they were two centuries ago. During the time of such an enormous increase in wealth, many of our problems should have been solved, but they were not, largely because an economic law was ignored. In the utilization of this new system, it will be of great benefit to the community if the laws of distribution are studied along with those of production.

In considering the parallel between scientific management and labor saving machinery, it should be noted that properly designed and labor saving machinery, when applied to a suitable purpose, has produced great economies and assisted materially in the production of wealth, but when improperly designed or improperly operated, it has been a source of expense. We may expect similar results from what has been called scientific management. If a proper scheme of management is devised, including proper tasks and compensation, without a question marked economies will be produced. If, on the other hand, employers are led, by the great advantages that can be obtained by this system, to adopt poorly designed schemes of management or to operate good ones in a poor manner, it is readily conceived that they may lose rather than gain by so doing.

The high-sounding term "scientific management" should not be allowed to mislead. It is not something that can be bought wholesale and utilized retail, but simply means that production problems must be studied according to scientific methods, eliminating guesswork, setting for each man a proper task, and according suitable rewards for accomplishing the task. In setting a task, emphasis should be put upon eliminating guesswork, for there is no surer way to cause dissatisfaction or inefficiency, than to change a task or a piece rate that has once been set in good faith. On the other hand, when the workmen realize that tasks once set will not be changed, and that they are set in an equitable manner, they not only do not object to the setting of tasks, but they do everything they can to help along the work.

In the following is given a description of the task and bonus system as devised and operated by the author.

Detailed Description of the Task and Bonus System

The employe is not told in a general way "to do better," but he has a definite standard set for him, and is shown how to reach that standard, for which he is awarded compensation in addition to his day's pay.

The system may be described in a general way as follows: A card is made out showing in detail the best method we can devise of performing each of the elementary operations on any piece of work, specifying the tools to be used, and giving the time needed for each of these operations, as determined by experiments. If a man follows his instructions, and accomplishes all the work laid out for him as constituting his proper task for the day, he is paid a bonus, in addition to his day rate, which he always gets. If, however, at the end of the day he has failed to accomplish all the work laid out, he does not get his bonus, but simply his day rate. The foremen receive, in addition to their day wages, compensation proportional to the number of their men who earn a bonus, and an extra compensation if all earn bonuses.

As the time for each detail operation is stated on the instruction card, the workman can continually see whether he is earning his bonus or not. If he finds an operation which he cannot do in the time set, he must at once report to his foreman, who must show him how to do it, or report to the man who made out the instruction card. If the latter has made an error, he must make out a new instruction card, explaining the proper method of working, and allowing the proper time. If, however, the instructor contends that the work can be done in the time set, he must show the workman how to do it. It is of the greatest importance that errors in making out instruction cards should be as few as possible.

As the cards are made out by a skillful man, with records of investigations at hand, they invariably prescribe a better method for doing the work than the ordinary workman or foreman could devise on the spur of the moment. As all the appliances and instructions necessary for doing the work are furnished, and a bonus is allowed the workman in addition to his regular rate if the work is done satisfactorily in the time set, it will be seen that this method is really a system of education with prizes for those who learn. The results obtained bear out this idea of education most fully, for under this plan men have learned more in a few months than the same men did before in years.

Scientific Method

In order to get the information needed to make good instruction cards, a great deal of detail work is necessary. When we realize, however, that any operation, no matter how complicated, can be resolved into a series of simple operations, we have grasped the key to the solution of many problems. Further study leads us to the conclusion that many different complicated operations are composed of a number of the same simple operations performed in different orders, and that the number of elementary operations is frequently smaller than the number of complicated operations of which they form the parts, just as the number of letters in the alphabet is smaller than the number of words in the language.

The logical method, therefore, of studying a complicated operation is to study the simple operations of which it is composed. In other words, the time needed for performing any complex operation must necessarily depend upon the time and method of performing the simple operations of which it is composed. Hence, the study divides itself into three parts, as follows:

An analysis of the operation into its elements.
A study of these elements separately.
A synthesis, or putting together of the results of our study.

This is simply the ordinary scientific method of procedure, followed whenever it is desired to make any kind of investigation. The ordinary man, whether mechanic or laborer, if not instructed, but left to himself, seldom performs any operation in the manner most economical either of time or labor. It has been conclusively proved that even on ordinary day-work, a very decided advantage can be gained by instructing the men how best to perform their work. When these instructions are the result of scientific investigation, the gain in efficiency is usually beyond our highest expectations.

Nearly every operation can be, and in actual work is, performed in a number of different ways; but it is self-evident that these ways are not all equally efficient. As a rule some of the methods employed are so obviously inefficient that they may be discarded at once, but it is often a problem of considerable difficulty to find out the very best method, and it is only by scientific investigation of all the elements, that we can hope to arrive at even an approximate solution.

Instruction Cards

When a task is set for any kind of work with which the men are not thoroughly familiar, it is obviously only simple justice to them that they should have detailed instructions how to accomplish each of the elements of the work in the time needed to earn the bonus. To get sufficient information to make out instruction cards suitable for permanent piece rates is often a long and difficult operation, but instructions may be made out to show the best method of doing work which we can devise with our present knowledge and appliances. Such cards may not represent the very best method of performing the work, but will usually represent a method far superior to that which the ordinary workman would employ. If we can get the men to do the work as directed on these cards, we can very largely increase the efficiency of their work; but to base a piece rate on such an instruction card would be simply inviting trouble, as but few men could see that it was just to change a piece rate when we changed the method of doing the work.

If, on the other hand, we allow the men their day rate and offer them a bonus for doing the work in accordance with our instruction cards, they see at once that they have nothing to lose by conforming to our wishes, and all to gain, with the result that in a short time they will make an effort to do the work in the manner and time set. We have found that there is practically no objection on the part of the men to a change of time on these cards, so long as the new time corresponds to a new set of instructions which will enable them, without additional hardship, to perform the work in the time set. This difference between ordinary piece work and our bonus system is fundamental.

Gang Bosses, Investigators and Instructors

In a shop operated on this system, where each workman has his task, one man whom we term a gang boss usually tends a group of workmen, supplying them with work and appliances and removing the work when finished. Such a man is paid a bonus for each workman who earns a bonus, and an extra bonus if all of his group earn bonuses. The result is that so long as the workmen perform their tasks, though nominally their boss, he is really their servant, and becomes the boss only when a workman fails to perform his task. The loss of money to the gang boss in case a workman fails to earn his bonus is such that he constantly has his eye on the poor workman and helps him all he can. If, however, he finds that the workman is incapable of being taught, he uses his influence to have a better man put in his place.

In starting a shop on task work, an instructor who is capable of teaching each workman how to perform his task must be constantly on hand, and must, as a rule, teach one workman at a time. This instructor may be the man who has investigated the work and set the task, or he may simply be an instructor capable of following out the work of such an investigator, but he must be readily available as long as any of the workmen need his services, for we make it a rule not to ask a man to do anything in a certain manner and time unless we are prepared to show him how to do it as we specify. If after having performed his task a workman wishes to suggest a quicker or better method for doing the same work, he is given an opportunity, if possible, to demonstrate his method. If the suggested method really proves to be quicker or better, it is adopted as the standard, and the workman is given a suitable reward. No workman, however, is allowed to make suggestions until he has first done the work in the manner and time specified.

It is the duty of the investigator to develop methods and set tasks, and unless the methods developed by him are generally a great deal better than those suggested by the workmen, he is not retained for the position. Working at tasks is pretty good training for task setting, and the writer has obtained more than one task setter from the ranks of the task doers. Inasmuch as, after a satisfactory method has been established, a large proportion of the work of the task setter is the study of the time in which the operations can be performed, he is popularly known as the "time-study" man. This term has led to a misconception of his duties, and has caused many honest people to claim that they were putting in our methods when they have put a stop watch in the hands of a bright clerk and told him to find out how quickly the best man was doing certain work. The time-study man must be of a far higher grade than this. To make real and permanent progress, he must be able to standardize appliances and methods and write such instructions as will enable an intelligent workman to follow them.

The Workmen's Relation to the System

The most intelligent of the workmen soon realize that we really mean to help them advance themselves, and the ambitious ones welcome the aid of our instructor to remove obstacles that have been in their way, perhaps, for years. As soon as one such man has earned his bonus for several days, there is usually another man ready to try the task, and unless there is a great lack of confidence on the part of the men in the management, the sentiment rapidly grows in favor of task work. When twenty-five per cent of the workers in a plant are "bonus-workers," they, with those who are striving to get into their class, control the sentiment, and a strong spirit of cooperation develops.

The development of skilled workmen by this method is sure and rapid, and wherever the method has been properly established, the problem of securing satisfactory help has been solved. The fact that the system works automatically, when once thoroughly established, puts the possibility of training their own workmen within the reach of all manufacturers.

Any system of management that did not make provision for obtaining proper materials to work with would be thought very lax. The day is not far distant when any management that does not make provision for training the workmen it needs will not be regarded as much better, for it is by this means only that a system of management can be made permanent.

An investigation of every case of lost bonus keeps the management closely in touch with the progress of the work, and as the workmen are ever ready to disclose and help remove the obstacles that prevent their earning their bonus, the managing problem is greatly simplified; for as one of my co-workers has very aptly put it, "the frictional lag due to the inertia of the workman is changed by the bonus into an acceleration."

* * *

The Pennsylvania Railroad is using reinforced concrete poles for carrying sixty aerial wires and two 1½-inch diameter lead-encased cables across the five miles stretch of swampy meadow-land just outside of the portal of the tunnels leading into the new passenger station in New York City. The concrete poles are used in order to avoid interruption from severe storms or fires from meadow-grass. The poles are from 35 to 65 feet in length and rise 25 to 50 feet above the ground.

* * *

Two men on a train argued as to the action of the vacuum brake. "I tell you it is the inflation of the tube that stops the train," exclaimed one. "Nothing of the sort," said the other. "It's the output of the exhaustion." At the next stop the matter was submitted to the decision of the locomotive engineer. He listened condescendingly to the arguments. Finally he said, "As a matter of fact you are both wrong. When we want to stop the train, we just open this valve which fills the pipe with vacuum."—*Exchange.*

THE MANUFACTURE OF MECHANICAL TOYS IN GERMANY

By CHARLES PABESHUTZ

Millions of dollars are spent every year for mechanical toys, but very little has ever been written regarding where and how these toys are made. The writer, therefore, will endeavor to give in the following a general idea of the manufacture of mechanical toys. Most of the smaller toys sold in this country are imported from Germany and France.

While almost every available material is used in the toy-making industry, the chief material is metal, and the manufacture of metal toys is the only one which is likely to be of especial interest to the readers of MACHINERY. In the

Fig. 1. The Plant of S. W. Guntherman, Nuremberg, Germany, devoted to the Manufacture of Mechanical Toys

manufacture of metal toys, up-to-date machinery, tools and devices are used. Most of the toys of other material than metal are made in the homes of the peasants of Oberammergau—a world-renowned place—in the mountains of Saxony, in Sonneberg and vicinity, and in Würtemberg. Mechanical toys are made principally in Nuremberg, Stuttgart and Berlin in Germany, Paris, Monbiliard, and Terre-noir in

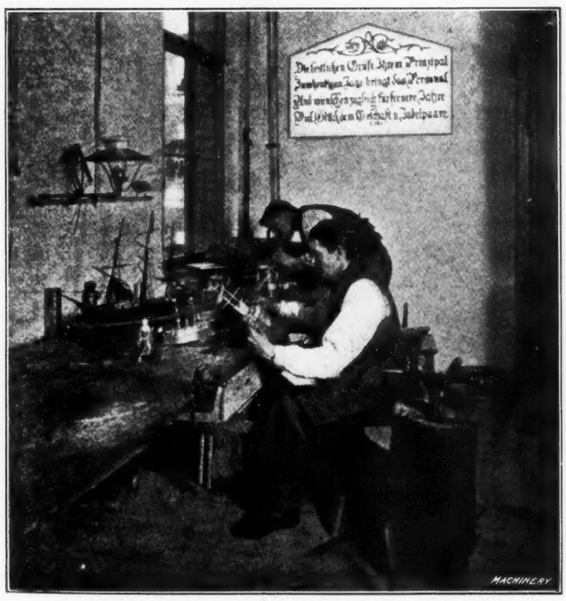


Fig. 2. The Experimental and Model Department

France, and Barcelona in Spain. It is safe to say that over 75 per cent of all mechanical toys are imported from Germany and France.

The manufacture of mechanical toys is an industry carried on in factories which can easily be compared with some of the plants of the big enterprises of this country, as, for instance, with those of the American Can Co. The machines and materials used are the same as those used by this company, and many hundred tool- and die-makers are constantly at work making the required tools for the sheet-metal work. The manufacture of toys requires considerable mechanical genius, and many great inventions have originated in a toy.

The best-known toy factories in Germany are S. Bing & Co., Nuremberg, employing 6000 people; S. W. Guntherman, Nurem-

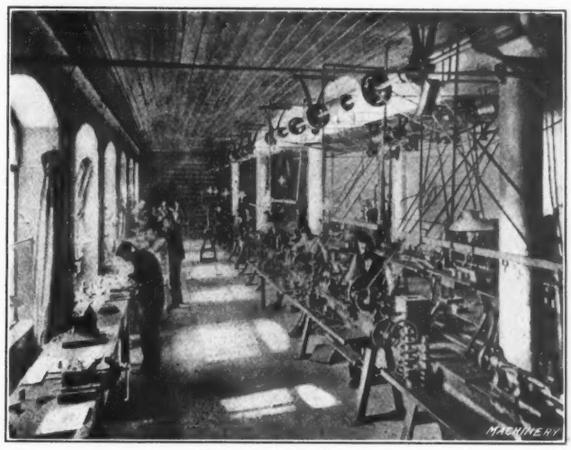


Fig. 3. The Tool-room

berg, with over 400 people; Georges Carette & Co., Nuremberg, with 500 people; George Schoenner, Nuremberg, employing 300 people; and Firma Lehman, Berlin. The leading manufacturers of mechanical toys in France are Rossignol (Vve. Ch. Rossignol et Cie., Succ.), and Roullet et Decamps, Paris; the leading toy manufacturer in Spain is Schul & Windisch, Barcelona.

The illustrations accompanying this article show various

Fig. 4. A Set of Combination Dies which produce from 12,000 to 15,000 "Automobile" Wheels per Day

views of the toy factory of S. W. Guntherman, Nuremberg. The writer has worked in this factory as a tool- and die-maker, and obtained there his first experience in the manufacture of toys. The plant of this firm, shown in Fig. 1, is a four-story stone and brick building covering an area of 40,000 square feet. The building is modern in every way and contains offices and sample-room, drawing-room, model-shop and experimental department, tool-room, press-rooms, tinshop,

Fig. 5. Press-room

painting and assembling department, department for clock movements, paper box department and store-rooms. Part of the experimental room where the models are completed is shown in Fig. 2. The exporters are called upon to decide as to the merits of the sample toys produced by the manufacturer. If the decision is favorable the men in the experimental room

are called upon to make all templets and models needed for the making of the tools, dies and special fixtures required in the manufacture of the toy.

Assume, for example, that a toy automobile with rubber tires is to be made, having a miniature chauffeur at the steering wheel and a clock movement to produce the motion. Such a toy can be bought for less than a dollar. Over fifty tools and dies are made for making the parts of this toy. All the templets or master blanks have to be cut by hand. Small prongs are provided on one blank, and corresponding slots in the other for assembling without soldering. It is important that soldering be avoided, as decorated tin is largely used.

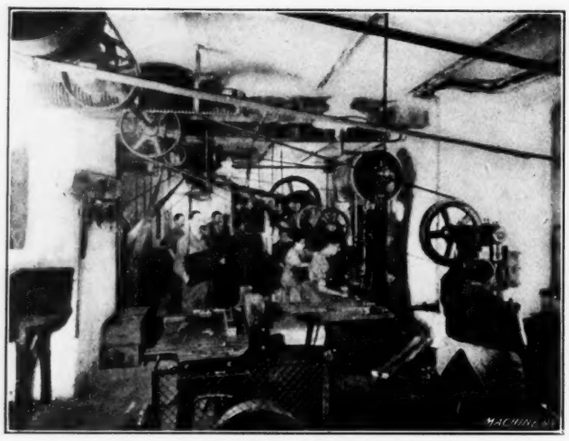


Fig. 6. Power Press and Shear Department

Fig. 7. Making Lead Castings

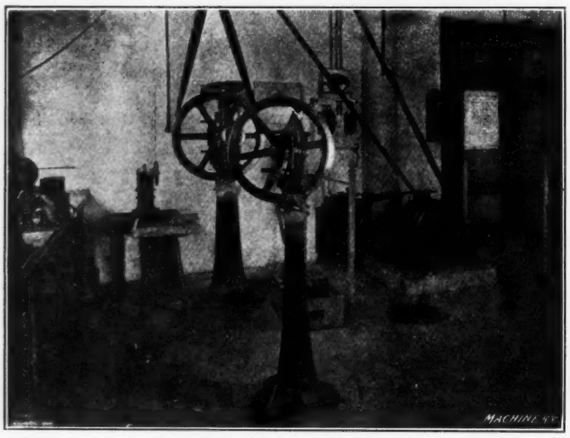


Fig. 8. Double-seaming Machines

Fig. 9. The Tin Shop

The most difficult and expensive part of the experimental work is to produce the models for such parts as the chauffeur, riders, horses, etc. These figures are first designed on paper and are then carved in wood to the required size and shape. The wood carving is used as a pattern from which a plaster-of-paris model is made and this model, in turn, is used for making a stamping die of fine gray cast iron. The punch working with this stamping die is made of babbitt, the shape being transferred from the die. The babbitt punch is fastened to a cast-iron punch holder. The model-maker is now ready to make his sample, which he trims off by hand. As soon as the model toy is completed, all the templets and master tools are sent to the tool-room, which is shown in Fig. 3. The tool-room, in this as in other sheet metal industries, is perhaps the most expensive department, as the very highest class of skilled men is required. The equipment of the tool-room is of the very highest class. In order to reduce the cost of the dies, the punches are usually finished in the shaper. As the irregularities of the blanks would call for so many special cutters for the milling machines, these latter machines are used only for punches for gear dies, etc.

Fig. 10. The Assembling Department

Fig. 11. Japanning and Painting Department

In Fig. 4 is shown a set of combination dies for making

automobile wheels. These tools will turn out wheels at the rate of 12,000 to 15,000 a day, finished in one stroke, which means that the blanking, forming or drawing, corrugating and piercing for the spokes and the center-hole, is all done at one stroke of the press. The hub is made of a small lead casting produced in a metal mold.

The presses are placed in two large rooms, one of which contains the hand screw presses and foot presses, as shown in Fig. 5, and the other containing the power presses, shears, etc., as shown in Fig. 6. Almost all the presses are operated by girls. From the press-rooms, the many thousand parts

Fig. 12. The Exhibition Room

are sent to the proper rooms to be assorted and kept in stock. All parts are inspected after completion, before being sent to the assembling department shown in Fig. 10.

The larger and more difficult parts are assembled by the tinners, while the smaller ones are assembled by girls. Many of the parts of toys of this kind are made of lithographed tin as already mentioned. Only blanks which cannot be machined without injuring the lithographic picture are hand painted. This work is also done by girls. The painted articles are placed in steam-heated compartments for drying the lacquer. Some of these compartments are shown to the left in Fig. 11. All the raw material and the half-finished and finished parts are stored in special storerooms.

An important part of the manufacture of mechanical toys is the making of the clock movements. The department where they are made is equipped with automatic and hand screw machines, automatic watch-gear cutting machines, and wire cutting and swaging machines. Millions of clock movements are turned out yearly. All the assembling of these movements is done by girls. The thousands of paper boxes used in packing the toys are also made in this plant.

CALCULATING GEARS FOR GENERATING SPIRALS ON HOBBING MACHINES

By GLENN MUFFLY*

From time to time formulas have been developed for calculating the gears to be used for generating spiral gears. Those published in the past, however, have applied only to certain types of gear-hobbing machines. In the following a formula is given which is applicable to any type of gear-hobbing machine, and which is simpler to use than any formula of this kind known to the writer. In developing this formula, simple arithmetical expressions have been made use of, as far as possible, in order to make it especially useful to the practical man.

In order to clearly understand the use of any formula, it is necessary to know something of the principles involved. Fig. 1 shows a top view of a standard hobbing machine (the No. 3 Farwell) designed for cutting spur gears. Before dealing with the change gear ratios for spiral work, it will be well to have the methods for cutting spur gears firmly fixed in our minds.

Assume the hob to be single threaded. It is evident that for each revolution of the hob, the gear being cut must move one tooth. Therefore, the hob revolves, for each revolution of the blank, as many times as there are teeth to be cut. To cut 44 teeth, we must gear the table to revolve once for every 44 revolutions of the hob.

The bevel gearing at D, Fig. 1, has a ratio of 3 to 1, the worm at E is double-threaded, and the worm-wheel F has 40 teeth. Hence the shaft B must revolve 3×44 times for each revolution of the table, and the worm shaft C must revolve 20 times for each revolution of the table. Hence we have:

$$\frac{\text{Revolutions of } B}{\text{Revolutions of } C} = \frac{3 \times 44}{20}$$

Inverting this ratio to get the change gear ratio required to obtain this result, we have:

$$\frac{20}{3 \times 44} = \frac{\text{Product of No. of teeth in driving gears}}{\text{Product of No. of teeth in driven gears}}$$

In the following formulas, we will designate the product of the number of teeth in the driving gears P, and the product of the number of teeth in the driven gears p.

Should we use a double-threaded or triple-threaded hob, the gear we are cutting must revolve two or three teeth for each revolution of the hob; in other words, the speed of the table is increased directly as the number of threads on the hob, so we must multiply the number of teeth in the driving gears by the number of threads on the hob, giving us this formula:

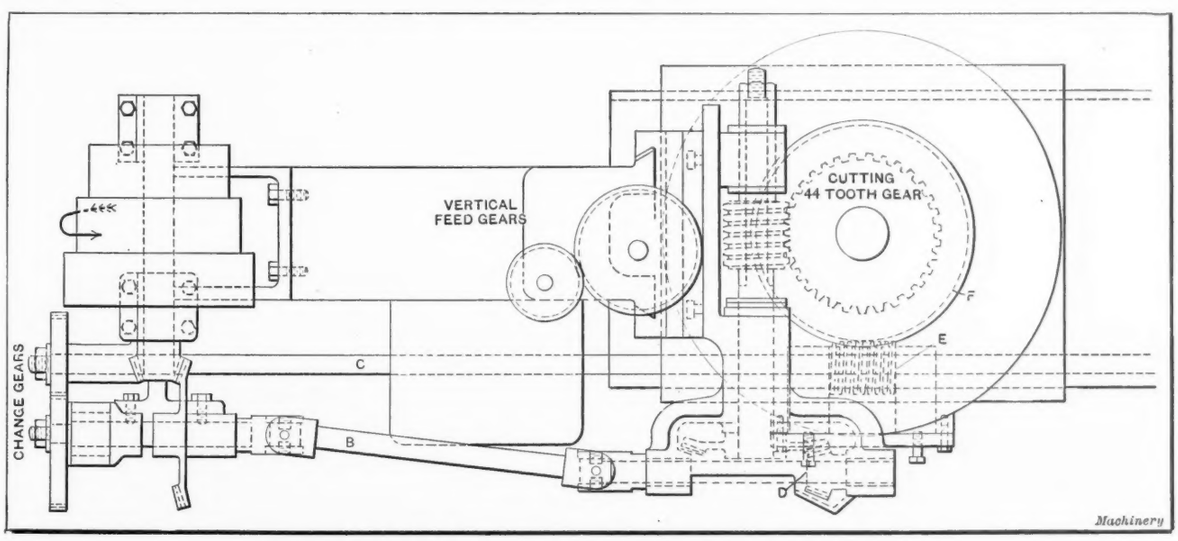


Fig. 1. Hob and Table Driving Arrangement of a No. 3 Farwell Gear-hobbing Machine

* Address: 107 Delhi St., Dubuque, Iowa.

$$\frac{20 \times \text{No. of threads on hob}}{3 \times \text{No. of teeth to be cut}} = \frac{P}{p}$$

A similar formula may be worked out in this way for any type of gear hobber.

Generating Spirals

For each revolution of the table, the head carrying the hob feeds down a certain distance across the face of the blank, this distance varying from 0.010 to 0.150 inch in common practice. To fully understand the following discussion, the action of the machine, as illustrated in Figs. 3 to 6, inclusive, should be noted. In Fig. 3 is shown the generation of a right-hand spiral gear with a right-hand hob; in Fig. 4, a left-hand spiral gear with a right-hand hob; in Fig. 5, a left-hand spiral gear with a left-hand hob; and in Fig. 6, a right-hand spiral gear with a left-hand hob. In each of these illustrations the direction of rotation of the table is indicated by the arrow showing the direction of rotation of the gear being cut. The direction of rotation of the hob is also indicated by an arrow showing the direction of rotation of its shaft. In Figs. 3 and 5, where a gear is cut with a hob of the same "hand," the angle a, as indicated, equals the difference between the tooth angle and the thread angle of the hob. In Figs. 4 and 6, where the gear and the hob are of different "hand," the angle a equals the sum of the tooth angle and the thread angle of the hob. After this preliminary introduction, we are ready to deal intelligently with the problem in hand.

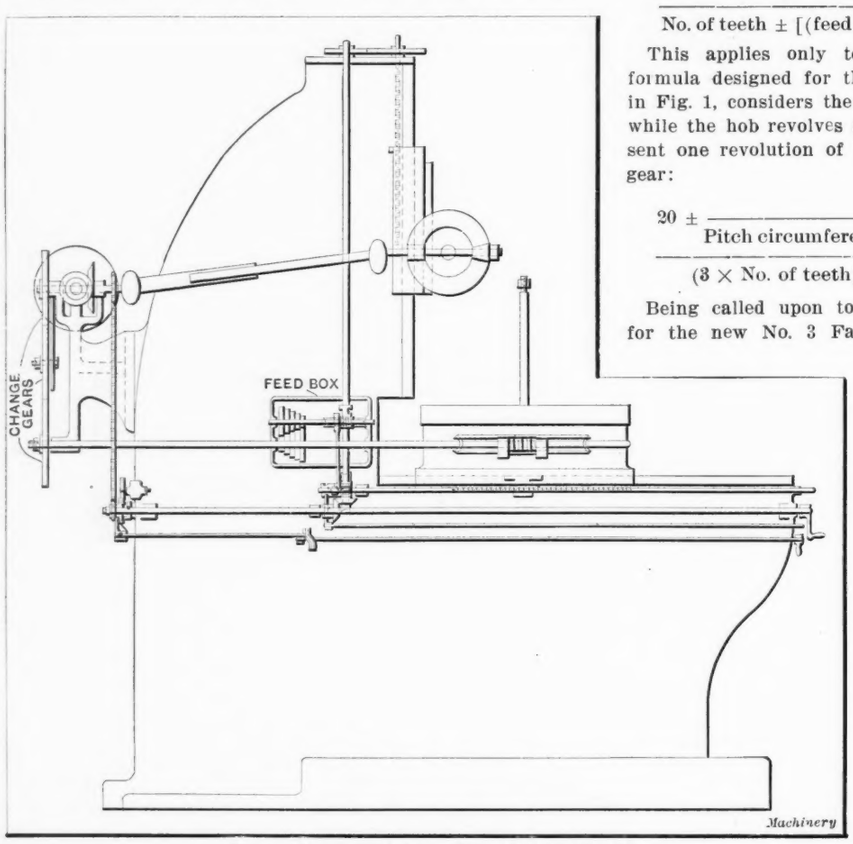


Fig. 2. Diagrammatic View of Gear-hobbing Machine

Assume the spiral gear shown in Fig. 7 to have sixty-four teeth. As indicated, the gear has a left-hand spiral and we will assume that it is cut with a left-hand hob. A single-threaded hob cutting a spiral gear would revolve sixty-four times for one revolution of the table; but since in this case the teeth are helical and the hob travels downward a certain distance, the position of the gear tooth must be advanced somewhat for every revolution with relation to the hob. In other words, if the hob revolves sixty-four times, sixty-four teeth will have passed by, but the blank is not in the same position as at the beginning.

In Fig. 7, G represents the position of the hob axis at the beginning of the cut and H the position of the hob axis after the hob has made sixty-four revolutions. This shows that the blank must make more than one revolution in this case. If we were cutting a left-hand spiral gear with a right-hand hob, as shown in Fig. 4, the blank would have to make less than one complete revolution for each sixty-four revolutions of the hob, the blank in this case being revolved in the opposite direction. It will thus be seen that when cutting a gear of the same "hand" as the hob, the table must revolve slightly faster than it would have to do when cutting a spur gear with the same number of teeth; but when the hob and the gear are of opposite "hand," the table must revolve more slowly than when cutting a spur gear. This has an important bearing upon the formula we are about to construct.

To gear the machine properly we must first find the ratio according to which the table is required to lag behind or lead ahead of its natural speed relative to the hob. In the first formula devised by the writer for the hobbing of spiral gears, the ratio was arrived at by considering the number of revolutions made by the hob, while the table makes one full revolution. The formula thus constructed for the No. 1 Farwell gear-hobbing machine is:

$$\frac{30 \times \text{No. of threads on hob}}{\text{No. of teeth} \pm [(\text{feed} \times \tan. \text{ of angle}) \div \text{circ. pitch}]} = \frac{P}{p}$$

This applies only to one particular machine. A later formula designed for the No. 3 Farwell machine, as shown in Fig. 1, considers the number of table revolutions required while the hob revolves a sufficient number of times to represent one revolution of the table, if we were cutting a spur gear:

$$\frac{20 \pm \dfrac{20}{\text{Pitch circumference} \div (\text{feed} \times \tan \text{ of angle})}}{(3 \times \text{No. of teeth}) \div \text{No. of threads on hob}} = \frac{P}{p}$$

Being called upon to derive another formula to be used for the new No. 3 Farwell universal hobbing machine, it occurred to the writer that a formula adapted to all hobbing machines would avoid much confusion. In the following is given the process by which such a formula was derived; the result is a simpler formula than any previously used.

The "lead" of a spiral gear is the axial length of the blank in which one spiral tooth makes a complete turn around the blank. Now, in hobbing a gear with a width of face exactly equal to the lead, it is evident that the blank must gain or lose one complete revolution as compared with the number of revolutions that would be made in cutting a spur gear with the same width of face and using the same feed per revolution of the blank. Assume that we wish to cut a 30-tooth, 10-pitch, right-hand spiral gear of 45-degree angle, using a single-threaded right-hand hob and feeding 1/32 inch across the face of the blank for each revolution of the blank.

The rule for finding the lead of a spiral gear is:

Pitch circumference $\times$ cot. of tooth angle = lead.

To get the pitch circumference, we must first find the pitch diameter; the rule for finding this in a spiral gear is:

Pitch diameter of spur gear $\div$ cos. of tooth angle = pitch diameter of spiral gear with the same number of teeth and pitch.

A 30-tooth, 10-pitch spur gear would have a pitch diameter of 3 inches. Referring to a table of trigonometrical functions we find that the cosine of 45 degrees is 0.70711; then, $3 \div 0.70711 = 4.242$ inches, which is the pitch diameter of the spiral gear. Multiplying this by 3.1416 gives 13.3267 inches, which is the pitch circumference of the spiral gear.

Since the cotangent of 45 degrees is exactly 1, multiplying by this gives the same quantity (13.3267 inches) as the lead.

The next step is to find how many times the blank must revolve while the hob feeds 13.3267 inches across its face. Since the feed is 1/32 inch (0.03125) for each revolution, we can divide by 0.03125 or multiply by 32 to get the number of revolutions. This gives 426.454 revolutions. The table has been traveling faster in relation to the hob than would be the case in cutting a spur gear with the same number of teeth; in fact, the table has gained exactly one revolution on the hob. In other words, the table speed in cutting this spiral gear is to the table speed in cutting an equivalent spur gear as 426.454 is to 425.454. From this we may construct the following formula:

$$\frac{\text{Lead} \div \text{feed}}{(\text{Lead} \div \text{feed}) - 1} = \frac{\text{required table revolutions}}{\text{normal table revolutions}}$$

For a gear of opposite "hand" from that of the hob the sign would be changed to + in this formula. Use the — sign only when gear and hob are of the same "hand."

By adding a 426-tooth gear to the drivers and a 425-tooth gear to the driven gears in the regular combination used to

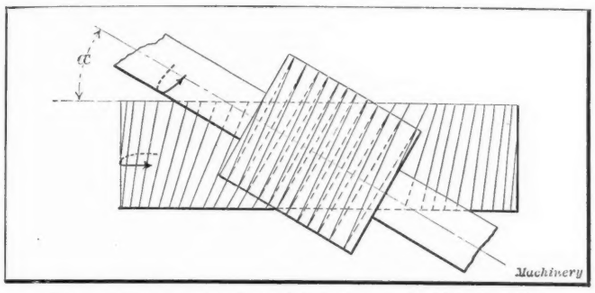


Fig. 3. Cutting a Right-hand Spiral Gear with a Right-hand Hob

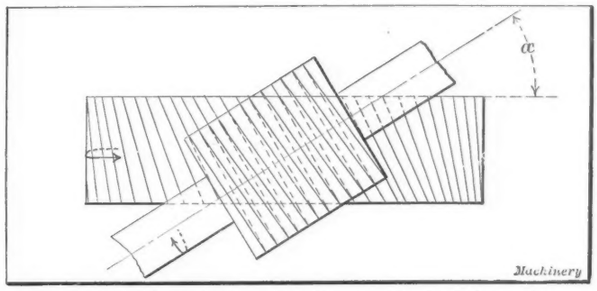


Fig. 4. Cutting a Left-hand Spiral Gear with a Right-hand Hob

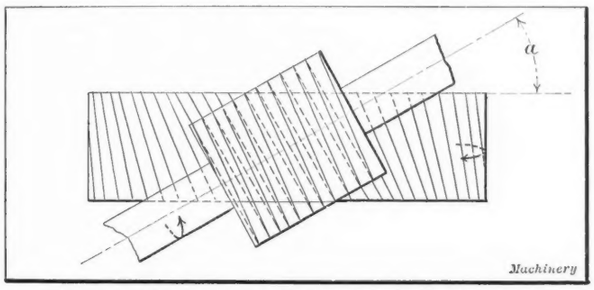


Fig. 5. Cutting a Left-hand Spiral Gear with a Left-hand Hob

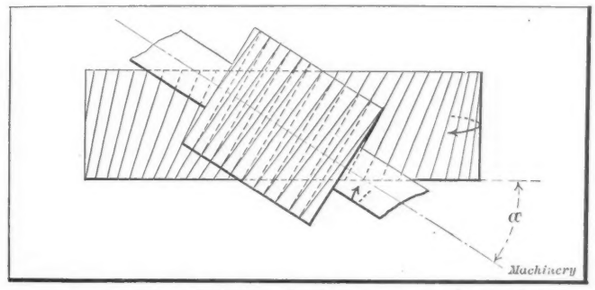


Fig. 6. Cutting a Right-hand Spiral Gear with a Left-hand Hob

cut a 30-tooth spur gear, we would get approximately the desired ratio, but for greater accuracy we can carry the figures to a few decimal places and factor:

$$\frac{42645}{42545} = \frac{8529}{8509} = \frac{3 \times 2843}{67 \times 127}$$

But 2843 is a prime number. We, therefore, try

$\frac{4265}{4255} = \frac{853}{851}$; but 853 is a prime number. We, therefore, try

$\frac{4264}{4254} = \frac{2132}{2127} = \frac{4 \times 533}{3 \times 709}$, but 709 is a prime number. Hence, we must make another slight change and try again, remembering that whatever change is made in the numerator must be exactly duplicated in the denominator to maintain the ratio as nearly as possible. The dropping of all decimals would cause a very small error, but dropping them from one side only would cause a great error. We find upon trial that

$$\frac{426}{425} = \frac{2 \times 3 \times 71}{5 \times 5 \times 17}.$$

Multiplying this with the change-gear combination ordinarily used to cut spur gears with 30 teeth, we have the gear combination required for any gear-hobbing machine used for cutting this gear. Thus, on the No. 3 Farwell universal hobbing machine, the spur gear ratio for cutting 30 teeth is $\frac{30}{60}$, which multiplied by $\frac{2 \times 3 \times 71}{5 \times 5 \times 17}$ gives $\frac{3 \times 71}{5 \times 5 \times 17}$, and arranging this ratio in convenient gear sizes, we have:

$$\frac{24 \times 71}{40 \times 85} = \frac{\text{Product of teeth of driving gears}}{\text{Product of teeth of driven gears}}$$

It will be noted that the last operation before factoring was to divide by the feed. Should prime numbers be encountered repeatedly in trying to factor, it is possible to get altogether new figures to work with, by making a slight change in the feed and dividing into the lead again.

Having found the gears, set the feed for exactly 1/32 inch per revolution, see that the table is revolving in the right direction, and tilt the hob spindle to bring the *thread angle* to 45 degrees and the machine is ready for business.

Recapitulation and General Remarks

The general formula for gearing any hobbing machine for generating spiral gears is thus:

$$\frac{L \div F}{(L \div F) \pm 1} \times \frac{P}{p} = \frac{S}{s}$$

in which

L = lead of spiral,

F = feed per revolution,

P = product of driving gears for cutting spur gears with same number of teeth,

p = product of driven gears for cutting spur gears with same number of teeth,

S = product of driving gears for cutting spiral gears,

s = product of driven gears for cutting spiral gears.

Use + sign when gear and hob are of opposite "hand," and — sign when they are of the same "hand."

In cutting teeth at large angles it is desirable to have the hob the same hand as the gear, so that the direction of the cut will come against the movement of the blank, but at ordinary angles one hob will cut both right- and left-hand gears.

The actual feed of the cutter depends upon the angle of the teeth as well as the vertical movement of the hob. This is obtained by dividing the vertical feed by the cosine of the tooth angle; thus:

$$\frac{0.03125}{0.70711} = 0.043 \text{ inch actual feed.}$$

The last computation need not be made except to see that we are not figuring on too heavy a cut, as it has nothing to do with the gearing of the hobbing machine. In setting up a hobbing machine for spiral gears, care should be taken

to see that the vertical feed does not trip until the machine has been stopped or the hob has fed down clear of the finished gear. Should the feed stop while the hob is still in mesh with the gear and revolving at the ratio required to generate a spiral, the hob will cut into the teeth and spoil the gear.

Should the thread angle of the hob be exactly equal to the tooth angle of the spiral gear, and both hob and gear be the same "hand," the axis of the hob spindle will be at right angles to the axis of the gear. This is in conformity with the rule that when hob and gear are of the same "hand,"

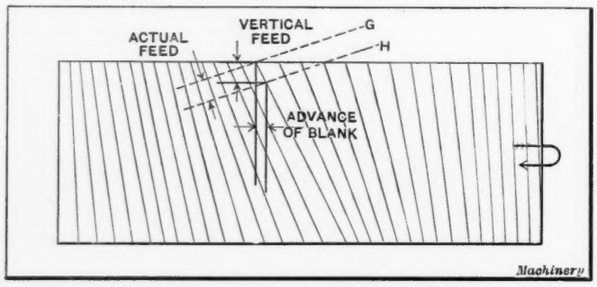


Fig. 7. Diagram showing Advance Required in Table Motion when cutting a Left-hand Spiral Gear with a Left-hand Hob

the hob spindle is set at the tooth angle minus the thread angle of the hob. In cutting a spiral gear to take the place of a worm-wheel, it is possible to use the same hob that was used in cutting the worm-wheel. This would be a case where it is not necessary to tilt the hob spindle. Sometimes multiple-threaded hobs are used in order to make the thread angle approximately equal to the tooth angle, when it is desired to cut spiral gears with machines on which the hob spindle swivels through only a small angle.

* * *

"CALORIZED" ELECTRIC SOLDERING IRON

The ordinary soldering iron has two serious drawbacks—the impossibility of keeping it hot continuously, and the rapid wasting away of the copper. The electric soldering iron has obviated the former difficulty, but the second fault has still remained in the improved electric type. Frequent renewals have been necessary, and hence there has been no reduction in the cost of maintenance. The General Electric Co., Schenectady, N. Y., has, however, made experiments in order to eliminate this drawback of the electric soldering iron, and recently a process of treating copper has been discovered which makes it possible to heat the copper to a high temperature without oxidation. At the same time corrosion caused by the acids used in soldering is eliminated, and the dissolving action of molten tin, with which the working tip of the soldering iron must always be coated, is reduced to a minimum. The "calorizing" process, as it has been called, changes the characteristics of the copper to an appreciable depth, so that the durability and working life of the soldering iron is increased to such an extent that marked economy results.

* * *

MAKING PORTLAND CEMENT

The following simple (!) directions for the making of Portland cement are taken from one of the leading daily papers of the Middle West. The clipping reads:

"It really seems as though nothing were worthless, if men only knew how to use it. The blast furnace affords an illustration. Stone is lighter than iron, and hence will float upon it like oil on water when both the stone and the iron are melted in a furnace. Some of the stone which rises to the top becomes slag. For years millions of tons of slag were thrown away or used to fill up gullies on vacant land. But at last a use was found for it worth while. It is thrown while white hot into water, and is at once without further ado changed into Portland cement. As cement was never so much in demand for all sorts of purposes as to-day it is fortunate that this very cheap way of making it was discovered. The man who first learned to do the trick deserves a monument more lasting than bronze."

"Why not erect a concrete monument? It would be so eminently fitting," says one of our contemporaries.

COMPOSITION AND CHARACTERISTICS OF STEEL AND IRON CASTINGS

The specifications given in the following article have been abstracted from a paper submitted to the Society of Automobile Engineers, which gives the desirable composition and characteristics of iron and steel castings, prepared especially for automobile construction. However, as a good and reliable casting can be made from the compositions given, their use will also be applicable to other classes of work.

Composition of Steel Castings

Carbon.....0.30 to 0.40 per cent (0.35 per cent, desired)
Manganese....0.60 to 0.80 per cent (0.70 per cent, desired)
Silicon.....0.10 to 0.30 per cent
Phosphorus, not over 0.06 per cent
Sulphur, not over 0.06 per cent

Steel castings are commonly made by open-hearth and crucible manufacturers. Genuine steel castings, and not malleable iron and complex mixtures often found on the market masquerading under the name of steel, are referred to in the foregoing composition. Genuine steel castings may be annealed or heat treated to advantage for important parts. A steel casting of the composition given should be tough enough to bend to a considerable angle before breaking. The elastic limit of such a casting in an annealed condition is about 35,000 pounds per square inch. Like other castings, steel castings are subject to blow-holes, consequently they should not be used for any vital parts. It is impossible to inspect castings for blow-holes so that axles, countershafts, steering spindles, etc., made from steel castings can be used only at great risk.

Composition of Gray Iron Castings

Total carbon..3.25 to 3.50 per cent
Manganese....0.40 to 0.70 per cent (0.50 per cent, desired)
Silicon.....1.90 to 2.20 per cent (2.00 per cent, desired)
Phosphorus...0.60 to 1.00 per cent
Sulphur, not over 0.10 per cent.

An analysis of cast iron in the present state of the foundry art is not easy. The foundryman if not accustomed to working to an analysis will object, although the iron he uses may be within the specifications given 98 per cent of the time. Moreover, if there are any defective cylinders he will likely blame the composition of the iron, whereas it may lie in his foundry methods apart from the composition. Consequently, these specifications should be used as indicated as the ideal mixture. If trouble is experienced with cylinders an analysis of samples of iron will show whether or not the composition is somewhere near what it should be, and if the composition is found to vary much from that given, the purchaser will be justified in putting up strenuous objections. Iron made to these specifications will be strong and reasonably cross-grained, and will wear well.

Composition of Malleable Iron Castings

Manganese....0.30 to 0.70 per cent (0.50 per cent, desired)
Silicon, not over....1.00 per cent (0.60 per cent, desired)
Phosphorus, not over.0.20 per cent (0.17 per cent, desired)
Sulphur, not over 0.06 per cent.

The remarks made in connection with gray iron castings apply even more strongly to malleable iron. Iron of the composition given properly annealed will make a strong and good casting, but if improperly annealed it will not make a good casting. Brittle castings as a rule result from two causes: First unsuitable mixture of iron, and second, improper annealing. Consequently, if brittle castings are received they should be analyzed, and if the analysis is correct, then it is certain that the annealing operation was not properly conducted. Malleable iron castings varying decidedly in composition from that given, especially as to phosphorus content, are liable to be brittle even if properly annealed, and should therefore be avoided.

* * *

A vote was taken among the members of the trade unions connected with the ship building and engineering industries in Great Britain, in order to ascertain whether the members were in favor of abolishing the premium bonus system. The returns of the voting were 10 to 1 for the abolishing of the system.

MILLING, CROSS-DRILLING AND BURRING ATTACHMENTS—4

APPLICATION TO THE BROWN & SHARPE AUTOMATIC SCREW MACHINES

By DOUGLAS T. HAMILTON*

Quite frequently it is found necessary to drill holes in both ends of a piece of work, which cannot be accomplished while the piece is attached to the bar, thus necessitating rehandling the work. The Brown & Sharpe Mfg. Co. has designed what is called a "burring" attachment, which is used in connection with its automatic screw machines for drilling and chamfering holes in both ends of the work. In this article reference is made to Figs. 4, 5 and 7 in the September, 1911, number.

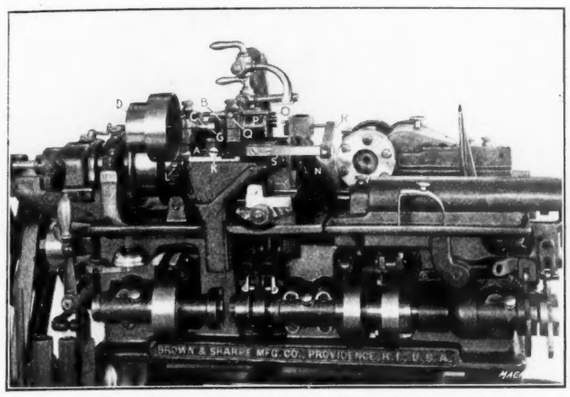


Fig. 26. Front View of No. 00 B. & S. Automatic Screw Machine equipped with a Burring Attachment

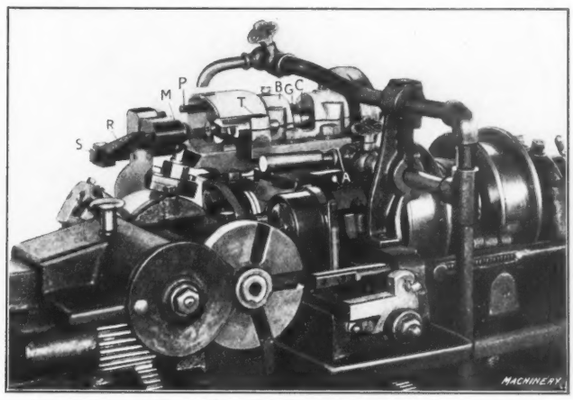


Fig. 27. Rear View of the Burring Attachment placed on a No. 00 B. & S. Automatic Screw Machine

Burring Attachment

A front view of the burring attachment fastened on a No. 00 Brown & Sharpe automatic screw machine is shown in Fig. 26. Fig. 27 shows a rear view, while Fig. 28 shows plan, end and sectional views, respectively. The attachment consists essentially of a cast-iron base *A*, provided with bearings *B*, in which a spindle *C* is free to rotate, being driven by the two-stepped cone pulley *D*. The bosses *B* are provided with phosphor-bronze sleeves *E* and a thrust washer *F*. The nut *G* is provided for taking care of the end play of the spindle. The burring tool is held in a bushing *H*, fitting in the nose of the spindle *C*, and is furnished with a clamping block *I* acted upon by a set-screw *J*.

This burring attachment can be adjusted to and from the machine by means of the collar-head screw *K*, and the top part of the attachment can be adjusted on its base in a plane with the axis of the spindle, by means of the collar-head screw *L*. The standard work-holder *M* is shown in section in Fig. 28, and more clearly in Fig. 32, to which reference should now be made. Here *A* is the chuck, slotted and spring tempered, *B* the chuck-closing sleeve and *C* the ejector. The chuck-closing sleeve is operated by means of a lever *D*, which is acted upon by pin *E*. To close the chuck, the arm *N*, Fig. 28, is made to dwell in an intermediate position between the work-spindle and the burring spindle, or, in other words directly in front of the chuck-closing device *O*. The arm *N* is then advanced, when the device *O* forces the sleeve *B* onto the chuck *A*, thus closing the latter on the work.

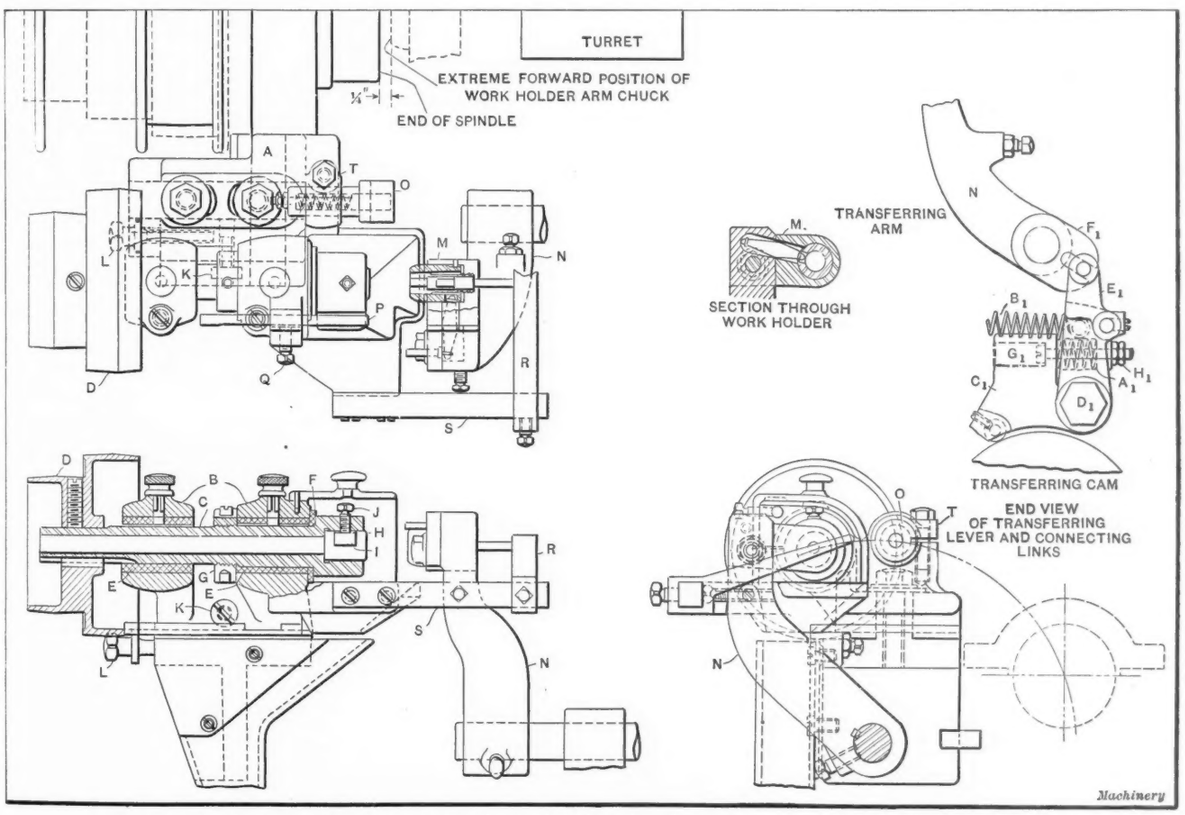


Fig. 28. Plan, Sectional and End Views of the Burring Attachment used on the No. 00 B. & S. Automatic Screw Machine

The chuck *A*, Fig. 32, which is screwed into the transferring block, is opened by means of the pin *E* coming in contact with the end of the rod *P* held in the burring head by a set-screw

* Associate Editor of MACHINERY.

Q, see Fig. 28. When pin *E* comes in contact with rod *P*, the former forces back lever *D*, which, in turn, releases the chuck-closing sleeve *B* and allows the chuck to expand, thus facilitating the removal of the work. The work is removed by means of the plunger *C*, which comes in contact with the finger *R*, Fig. 28, when the arm *N* drops back. This finger is held by a set-screw on a square rod *S*, which, in turn, is fastened to the base of the burring attachment.

Referring now to the view to the right in Fig. 28, the transferring arm *N* is made to dwell in an intermediate position

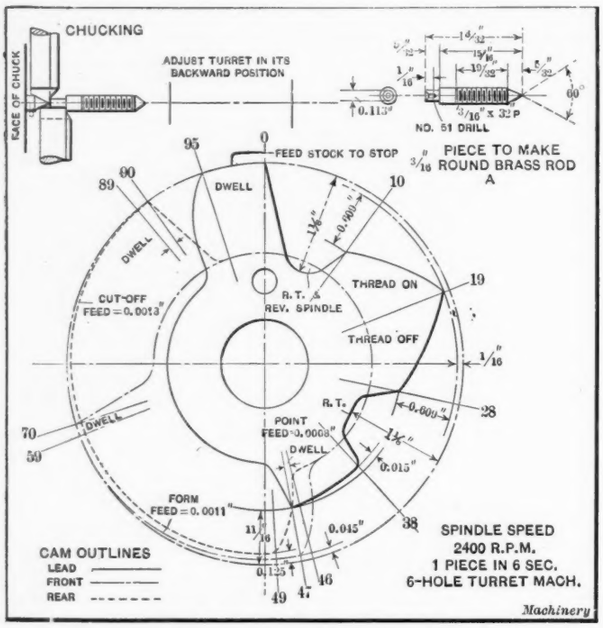


Fig. 29. Lead and Cross-slide Cams for Making a Cone-pointed Screw having a Hole drilled in the Rear End

by the combined action of the two cams—transferring and burring—and the two springs A_1 and B_1. The transferring lever C_1 is fulcrumed on the stud D_1 and works in a slot in the connecting link E_1. The link E_1, in turn, is connected to a slotted block F_1, which is fastened to the transferring arm shaft by a cone-pointed set-screw, not shown. The spiral spring A_1 bears against the face of the transferring lever C_1, the transferring lever being held to the link E_1, by means of the fillister head screw G_1 and two check nuts H_1. The spring B_1 is used to keep the roll in the lever C_1 in contact with the transferring cam, while the spring A_1 is used to steady the transferring arm. When the set-screw in the arm *N* comes in contact with the square rod *S*, the lever C_1 continues compressing the spring A_1, thereby keeping a tension on the arm *N* while the burring operation is being performed. The spring B_1 is fastened to the link E_1 and to the tray or bracket-holder for the transferring arm rod. The height of the lobe on the transferring cam governs the angular position of the arm *N*.

Laying Out Cross-slide and Lead Cams for Burring Operation

The same remarks which we made in the November number in regard to laying out cross-slide cams for cross-drilling operations apply to the laying out of cross-slide cams for burring operations, it being absolutely necessary to leave sufficient clearance for the arm to ascend and descend to and from the work-spindle. The character of the work and the shape and size of the work-holder also play an important part in regard to the amount of clearance necessary. This, of course, has to be worked out for each individual case. To illustrate clearly the method of designing a set of cams which accomplish a burring operation, we will lay out a complete set of cams for producing the cone-pointed screw shown at *A* in Fig. 29. As can be seen a No. 51 drill hole is to be produced in the rear end of this screw, which without the use of this attachment would necessitate rehandling the work and performing a second operation on it.

The cross-slide and lead cams for making this screw are also shown in Fig. 29, where the functions of the various lobes are clearly indicated. It might be mentioned, however, that it was necessary to adjust the turret slide back to the extreme limit to make this long screw in a No. 00 B. & S. automatic screw machine. The time allowed to feed stock is also less than that usually provided, being 5 hundredths instead of 10 hundredths of the cam circumference. The reason for this is that the turret is not revolved, but is just advanced to gage the stock to length.

Laying Out the Transferring and Burring Cams

Before proceeding to lay out the transferring and burring cams, a diagram similar to that shown in Fig. 30 should be made. Here the work-chuck, chuck-closing device, burring tool and chuck-opening pin should be laid out in their respective positions, and the angular movement of the arm from one point to the other should be determined.

A good method for obtaining the angular movement of the arm *A*, is to make a diagram as shown in Fig. 30, drawing in all those parts which are designated by full lines. Then make a templet of the arm *A*, work-holder *B* and slotted block *C*, on tracing cloth. Now by pivoting this templet on the center of the transferring arm rod, and swinging it around to the various positions, the lines *D*, *E*, *F* and *G* can be drawn, which represent the center of the slot in the block *C*, when the arm is swung to the various positions. Next draw the circles *H* and *I*, representing the largest and smallest diameters of the

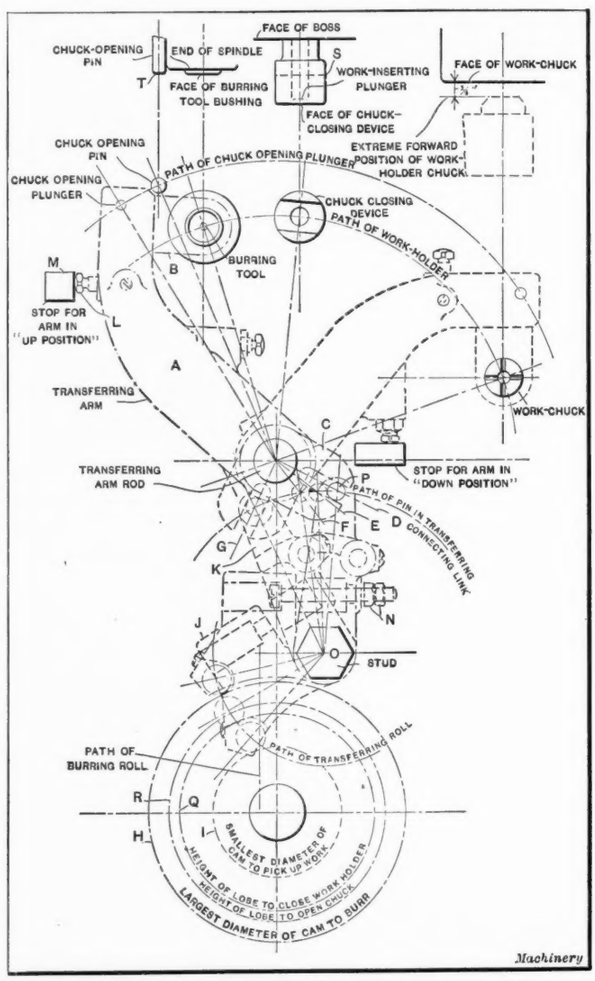


Fig. 30. Diagram used in Determining Rises on the Transferring and Burring Cams

transferring cam, after which a templet of the transferring lever *J* and connecting link *K* should be made on tracing cloth.

As was previously mentioned, the lever *J* should compress the spring A_1, see Fig. 28, when the set-screw *L* touches the square rod *M*, thus steadying the arm during the burring operation. To provide for this the nuts *N* are adjusted, so that the spring A_1 will bear the weight of the arm *A*. To proceed, pivot the templet of the transferring lever and con-

necting link on the center of the stud *O*, swing the templet so that the center of the pin *P* comes in line with the lines *E* and *F*, respectively, and draw circles *Q* and *R* representing the heights of the lobes for closing and opening the chuck. Care should be taken in laying out the lobes to lift the arm from the chuck-closing device to the chuck-opening pin, as the space between the two members is not adjustable.

As the spring A_1, see Fig. 28, is compressed further when the arm *A* is in the "up position" than when it is in the "down position," it is necessary to start swinging the arm *A* from the work-chuck, and to proceed towards the burring tool. It will be found that the roll in the lever *J* will fall below the largest diameter of the cam, when the arm is in line with the burring tool; this allows the spring A_1 to be compressed and thus steady the arm.

To obtain the heights of the lobes on the burring cam, a diagram similar to that shown in the upper view of Fig. 30, should be made. The burring tool should be drawn in position, as well as the work in the work-chuck. The chuck-closing device *S*, and chuck-opening pin *T* are adjustable within a considerable range, but it is best to work from a setting which will be most convenient to the burring tool and work.

The method used in obtaining the heights of the lobes on the advancing cam was described in connection with Fig. 4, while the proper procedure to follow in laying out the lobes on the transferring cam in their correct relation to the lobes on the advancing cam was described in connection with Fig. 5. The diagrammatical method used in laying out the transferring and advancing cams for the Nos. 0 and 2 B. & S. automatic screw machines was illustrated in Fig. 7.

The transferring and burring cams used in connection with the piece shown at *A* in Fig. 29 are shown in Fig. 31, as is also a sectional view of the work-holder with the work in position. The order of operations for making the piece shown at *A* in Fig. 29, is as follows:

Lead and Cross-slide Cams

Operations	Revolutions	Hundredths
Feed stock to stop	12	5
Revolve turret and reverse spindle	24	10
Thread on	21.6	9
Thread off	21.6	9
Revolve turret	24	10
Point, 0.015 inch rise at 0.0008 inch feed, dwell 0.10	21.6	9
Form, 0.045 inch rise at 0.0011 inch feed, dwell 0.10	(55.2)	(23)
Cut off, 0.125 inch rise at 0.0013 inch feed, dwell 0.10, and revolve turret four times	98.4 + 4.8	41 + 2
Clearance to bring down arm	12	5
Total	240	100

Transferring and Burring Cams

Operations	Revolutions	Hundredths
Drill and countersink, 0.070 inch rise at 0.00162 inch feed, dwell 0.20	48	20
Drop back with piece	7.2	3
Rotate to open chuck	28.8	12
Dwell on burring cam to open chuck	2.4	1
Drop back to eject piece	10.7	4½
Drop down to grip work	36	15
Dwell with arm before advancing	4.8	2
Advance on work	21.6	9
Raise arm to close chuck	26.4	11
Advance arm to close chuck	9.6	4
Close chuck	2.4	1
Rotate to burring spindle	19.2	8

Referring to Fig. 31, the lobe *A* on the burring cam moves the arm forward to close the chuck, and during this period the transferring arm roll is on the "dwell" on the lobe *B* of the transferring cam. The springs previously referred to steady the arm when in this intermediate position, but on account of this undependable method of steadying the arm, it is not advisable to make a piece in less than three seconds on the No. 00 B. & S. automatic screw machine.

Work-holders and Chuck-closing Devices

The standard work-holder furnished in connection with the burring attachment is shown in detail, connected to the arm *N* in Fig. 32, where its construction can be clearly seen. The operation of this work-holder has been described, but it may be advisable here to give a few more particulars regarding it. The diameter *G* of the chuck *A* is made equal to the maximum diameter of the work. The chuck-closing sleeve *B* is made with a tapered hole to suit the chuck *A*, the taper being about ten degrees, and is provided with a slot in which a pin *F* fits, preventing the sleeve from turning around. The sleeve is also cut out to receive the ball end of the lever *D*, which is used for releasing it from the chuck, thus allowing the work to be pushed out by the plunger *C*. The lever *D* as before mentioned, is operated by means of the headed pin *E*.

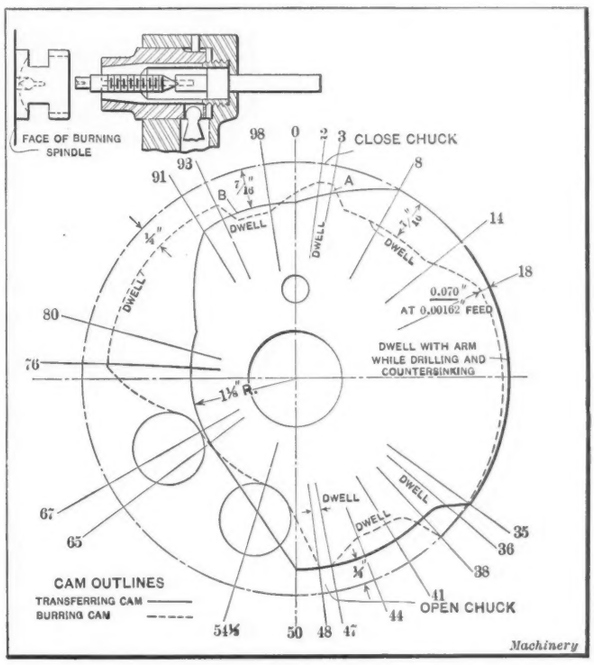


Fig. 31. Transferring and Burring Cams for the Piece shown at A in Fig. 29

Another type of work-holder, which was developed for a special piece, is shown in Fig. 33. This was for holding the threaded piece *A*, which, as can be seen, could not be gripped in a chuck of the type shown in Fig. 32 on account of the end which is placed in the chuck being tapered and threaded, thus preventing the chuck from gripping it securely. The work-holder consists essentially of a machine steel block *B* of

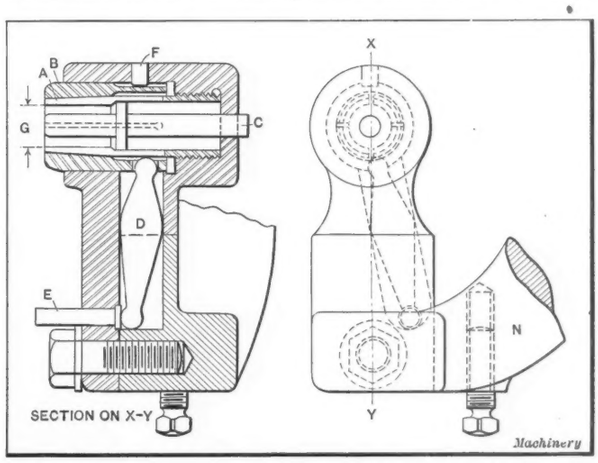


Fig. 32. Standard Work-holder used in Connection with the Burring Attachment

the shape shown, which is fastened to the transferring arm by a cap-screw. This block is provided with a boss in which holes are drilled for the work-holder *C*, locating pin *D*, and ejecting pins *E*. The locating pin *D* comes in contact with the flats of the hexagon, and thus prevents the work from turning around on the work-holder *C*. The work-holder *C* is driven into the block *B*, and two studs or pins *E* pass through the block *B*, on the forward end of which is fastened an ejecting block *F*, forming a link connecting the two studs. The rear ends of these studs are also provided with a link *G*

held to them by nuts *H*. An adjustable pin *I* located in the link *G* is retained by the set-screw *J*. This pin *I* comes in contact with the finger *R*, Fig. 28, and ejects the work after it has been burred.

The standard chuck-closing device provided with the burring attachment shown at *O*, Fig. 28, is shown more clearly at *A* in Fig. 34. It consists of a body *b* provided with a slot *c* in its front end through which the chuck passes on its transit from the work-spindle to the burring tool. The body *b* is counterbored to receive the spring plunger *d*, which is acted upon by the spiral spring *e*. The plunger is adjusted by means of the check-nuts *f*, and forces the work into the chuck *A* against the ejecting pin *C*, see Fig. 32.

A special locating device used in connection with the work-holder shown in Fig. 33 is shown at *B*, Fig. 34. This,

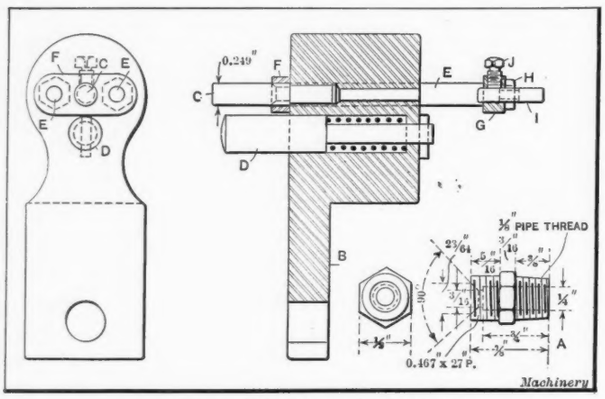


Fig. 33. A Work-holder of Special Design

as before, consists of a body *g*, which fits in the clamping bracket *T* on the burring attachment (see Fig. 28). The device is provided with a spring plunger *h* acted upon by the spring *i*, and is retained in the holder by means of pin *j*. This plunger *h* is used for forcing the work onto the pin *C*, Fig. 33. The plunger *k*, which rotates the work *A*, Fig. 33, on the work-holder, and thus locates it correctly against pin *D*, is held in a bushing *l* counterbored to receive a spring, and is retained in the holder by means of the pin *n*. The bushing itself is held in the holder by means of the set-screw *o*.

Burring Tools and Holders

The type of burring tool and holder used in the burring attachment is governed entirely by the work it is to perform.

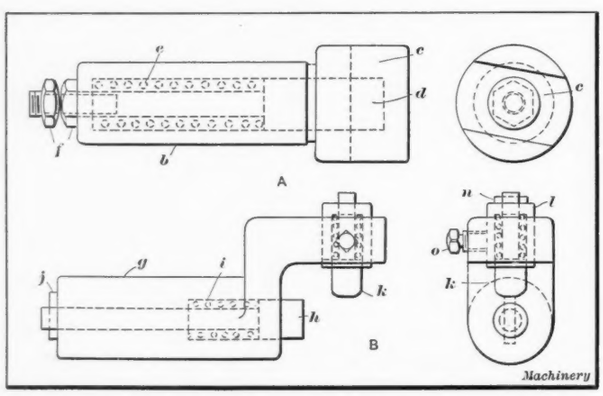


Fig. 34. Standard Work Chuck-closer, and Device for Locating Work on the Holder shown in Fig. 33

In Fig. 35 are shown a few representative types of burring tools and their respective holders. *A* is the burring tool used for burring the piece shown at *A* in Fig. 33. This is made from round drill rod, as shown, and is provided with a leader fitting in the work, the cutting face being tapered to the required angle. The type of burring tool and holder used for drilling and countersinking the screw shown at *A* in Fig. 29, is shown at *B*. The holder *a* is made to fit in the burring spindle, and is slotted out to receive the clamping block *b*. A combination drill and countersink *c* of the required shape and diameter is held in this holder by means of a set-screw bearing on the clamping block. The front end of the holder is counterbored to receive the work-holder chuck, and is also provided with two slots *d* which allow the chips to escape.

Another type of burring tool, and the work on which it is used is shown at *C*. In this case the burring tool is a combination holder and tool, being made to fit the hole in the burring spindle. It is also provided with a leader *e* to fit the work, which is turned down on the rear end to suit the holder and held in it by a set-screw as shown.

Three views of still another type of burring tool and holder are shown at *D* and *E*. This holder and tool is used principally for chamfering the inside and outside of tubing as shown at *f*. The tool used is similar to a circular form tool except that it is of small size. It is held in the holder *g* on a stud *h*, which is threaded into the holder and is provided with a nut *i* for locking it in the desired position. The stud carrying the circular tool is slotted in the lower end, so that it can be adjusted, thus bringing the tool in the correct position to chamfer the inside and outside of the work.

The circular tool *l* is held on the stud by means of a screw *j* and washer *k*. The front end of the holder is provided with a bushing *m*, which fits the external diameter of the work and is held in place by a headless screw as shown. When designing this type of tool, it is preferable to lay out the work on a large scale, about 10 to 1, and from this obtain the diameter of the tool, and the distance it is to be cut

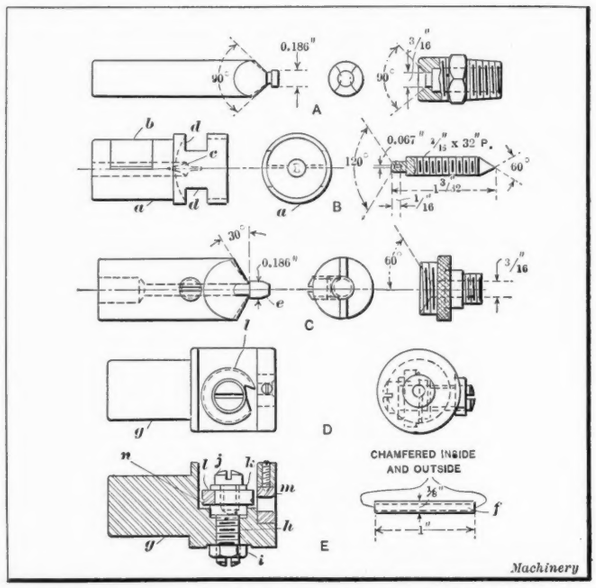


Fig. 35. Various Types of Burring Tools and Burring-tool Holders

down below the center, so that the tool will clear and not rub, which would tend to produce a poor finish on the work. The depth of the recess *n* should only be a few thousandths greater than the length of chamfer required on the work, because the greater the depth *n*, the smaller the diameter of the tool, and also the smaller the amount of tool circumference that can be utilized for cutting. From the diagram the location of the stud *h* can also be obtained.

Speeds and Feeds for Burring

The speeds used for burring when the tools are made from ordinary carbon steel should be similar to those used for drills, a table of which was given in the September, 1910, number of MACHINERY. The feeds used where the burring tool is smaller in diameter than ¼ inch should never be greater than 0.003 inch for brass, 0.002 inch for machine steel, and 0.001 inch for tool steel. The feeds should also be decreased near the end of the cut, and a dwell equal to at least three revolutions of the burring tool should be allowed on the burring cam. Where the burring tool is ¼ inch or greater, the same feeds as those used for centering tools, given in the article previously referred to, can be used with satisfactory results.

REMARKS BY THE ONLOOKER

It is not unusual to come across some mechanical idea which makes one wonder why it has never been thought of before. In the advertising pages of the November number of MACHINERY is shown a high-speed drill press which prompted this reflection. The drill press has an arm which can be swung out of the way, and in it is a removable bushing to steady the drill; in other words, the attachment is the simplest kind of a jig, and a very effective one. I can see no reason why this simple fixture cannot be fitted to the usual type of sensitive drill press, as well as to the round-column type shown.

To produce an elongated hole in a piece of steel, in a drill collet or drill spindle, is usually a difficult job. In most shops it is done by laying out and drilling several holes, and then filing out the metal between them. This requires considerable time, and the work is often unsatisfactory. It is, therefore, a revelation to compare with the results thus obtained those shown on page 5 in the advertisements, produced by a specially designed spline milling machine. When these holes are produced in the usual way, the table of time required would almost have to read "hours" for "minutes," and "minutes" for "seconds," to say nothing of the quality of the work.

Keyseats are another thing which the average shop finds expensive to cut. A shaper is commonly used with a long tool which is, of course, expensive, and at best a "nibbling" affair. The keyseating arrangement shown on reading page 171 (engineering edition) is inexpensive and effective, but I cannot think that the grinding rig also shown can be considered more than a makeshift of questionable wisdom, as a grinding machine always requires special provision to prevent the abrasive from working into the moving parts and joints. Without such provision, the life of the tool is shortened and its accuracy impaired. The arrangement, however, is most handy at times in a shop where it would not pay to install a surface grinder; with careful cleaning, injury to the machine can be largely averted.

The portable grinder is becoming more and more understood and appreciated. The pages of the technical press show how it has made its way into the shops, air and electricity being the motive power. In small shops the electric tool seems to be far cheaper to install, but in large shops the air-driven tool has some great advantages. Even for shops of medium size, small air-compressor sets are obtainable at a moderate cost. In many cases portable tools can complete the work, and the machine can be carried to the part to be machined much quicker than the part can be carried to a stationary machine. Furthermore, portable tools can be used while other operations are carried out on the same piece.

A very useful table is given on page 220 of the sizes of the small ends of taper pins; it is a wonder that taper-pin makers have not provided such a table long ago. If it has ever been published, I have never happened to see it.

The editorial and the articles on the prevention of accidents bring to my mind very forcibly a remark attributed to Bismarck: "All but a fraction of mankind is unable to take care of itself, and even that fraction cannot be depended upon at all times." The idea that it is a disgrace for a person to become injured is, to my mind, a correct one. Ridicule or disgrace is something that few can stand, and that it is unpardonable to hurt others should be duly impressed upon all, including the proprietor who does not provide reasonable guards against thoughtlessness.

I have had an experience with large corporations in this connection. I was interested in sanitary conditions with a view of preventing tuberculosis, and in no case did I meet with any objection to the suggestions made to add to the comfort of the workman or to prevent accidents or illness; instead, the suggestions were acted upon at once. To prevent accidents is the desire of any right-minded man, and I think we are safe in assuming Bismarck's utterance to be true, although I do not think that to relieve a man from all responsibility is wise. The New Jersey accident law, lately passed, relieves the workman of responsibility under all circumstances, no matter if his injury is the result of direct disobedience. The fact that he is hurt is all that is necessary to entitle him, under the law, to a money compensation, the amount of which is fixed. In my personal opinion such a law will lower the standard of moral responsibility, just as, I believe, the pension act in Germany has deteriorated the German character. When people are relieved of responsibility they degenerate.

To illustrate the desire of proprietors to prevent accidents, I was recently in a New England shop when a salesman representing a concern making hollow set-screws called. After he had told his story, the customer asked how soon he could get the set-screws required, and was assured that they could be furnished out of stock. At noon there were ten or twelve men busy taking out the set-screws in the lineshaft pulleys and replacing them with screws of the hollow style. Before the end of the week no projecting screws could be found in the establishment. These hollow set-screws are of great value not only as accident preventors, but from the point of economy, as so few lengths have to be carried in stock.

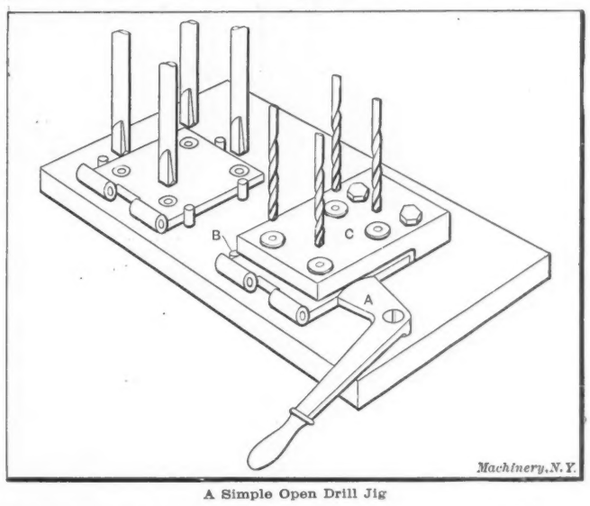
The account given in the November number of the extruded tubes reads like a fairy tale, and illustrates how persistency pays not only the inventor, but the world. It seems almost incredible that such work can be done cold, and the inventor, and those who had the stamina to risk their money on the process, should be commended. Few men, however well versed in metal drawing would have believed the process possible—let alone practicable—before it was actually demonstrated. We are often astonished at what is possible. I recently saw a lot of small bent wire pieces which had been japanned, and could not understand how the work could be so evenly done. I was told that the articles were put in a tumbler with the japan and after having been tumbled a few minutes by hand they were dried in an oven. I could hardly believe this, but I saw it done, and the only additional treatment was to occasionally shake the pans in which the articles were dried. The shaking seemed to be the secret of the process and prevented the wires from sticking together when drying.

In talking with a reader of MACHINERY a few days ago he said: "I now keep the issues of this journal instead of catalogues. I had such a number of catalogues that I could not care for them properly, and I found that practically everything in my line was advertised in MACHINERY, so I threw away the catalogues to save space." W. D. F.

* * *

A SIMPLE AND EFFICIENT DRILL JIG

The accompanying illustration shows a simple and efficient drill jig for drilling and countersinking hinges in an eight-spindle multiple drill press. These hinges are 3 1/2 by 3 5/16 inches and are held for drilling by the cam *A*, which presses the hinge against pins *B*. The bushings are held in a top



A Simple Open Drill Jig

plate *C*, which is fastened to the base by cap-screws, as shown. The holes in the hinge are countersunk at the left of the jig, being located in the proper position by four pins, as shown. This type of jig is shown in *The Driller*, issued by the Baush Machine Tool Co., Springfield, Mass.

METHODS, MACHINES AND FIXTURES FOR AUTOMOBILE MANUFACTURE*

PRACTICE OF THE NATIONAL MOTOR VEHICLE CO.

By F. B. HAYS†

The plant of the National Motor Vehicle Co., Indianapolis, Ind., is one of the oldest automobile factories in the United States, and contains some very interesting special tools and machinery. The general methods used in manufacturing the

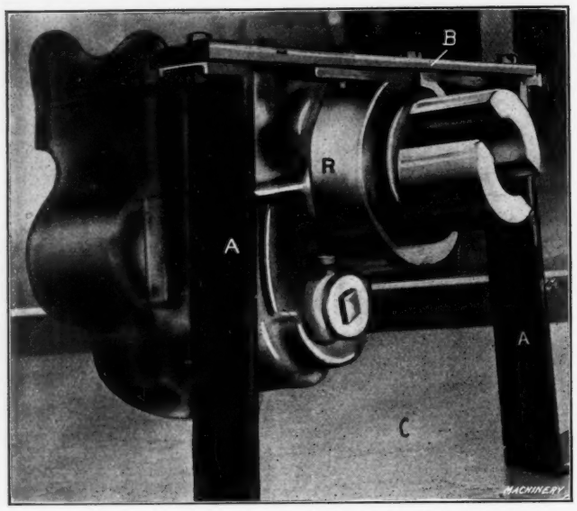


Fig. 1. Fixture for Holding Transmission Cases while Assembling

automobiles made by this company are similar to those used in other motor car factories. However, many of the individual processes, machines, tools, and jigs are peculiar to the National Motor Vehicle Co.'s plant.

Transmission Fixture

Fig. 1 shows a fixture for holding transmission cases while assembling. It is made of two vertical pieces of angle iron *A*,

Fig. 2. Valve Grinding Machine

and one horizontal piece of flat stock *B*, bolted together and screwed to the assembler's bench *C*. Bolted to the middle of piece *B* is a ring *R* which has the same inside diameter as the cylindrical end of the transmission case. This ring clamps around the end of the case and holds it in position while the transmission is being assembled. This arrangement permits the case to be held at any angle with its vertical axis while being worked upon.

Valve Grinding Machine

One of the most interesting machines in the factory is that used for grinding intake and exhaust valves shown in Fig. 2. This machine is driven by the driving shaft *A*, which is rotated by the belt *R*. Shaft *A*, in turn, revolves the grinding spindles *B* through spiral gearing, and the cam-shaft *C* by means of the belt *W*. Into the lower ends of the grinding spindles *B* are inserted rectangular drivers which fit into the slots of the valve heads and which cause the valves to rotate with the grinding spindles. By means of the springs *S*, considerable pressure is exerted by the grinding spindles on the valve heads. The grinding spindles are splined, and are free to move vertically in their gears. As the grinding spindles revolve, the arms *X* are raised and lowered by cams on shaft *C*, which produces a slight vertical motion of valve stems *V*.

The operation of this machine is as follows: The springs *S* are unhooked and the grinding spindles *B* raised to clear the cylinders *H*. The latter are then slid into place in the

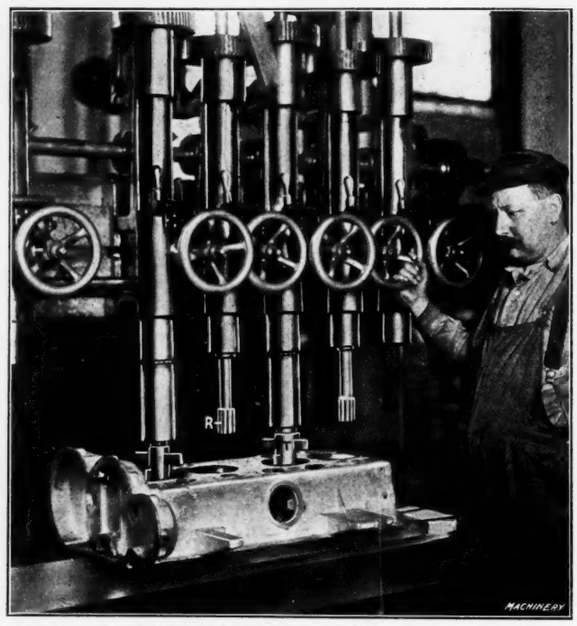


Fig. 3. Boring Cylinder Holes and Reaming Push-rod Holes in Crank-case

slots on the base of the machine, so that the valve centers come approximately central with the centers of the grinding spindles. The valves and valve seats are then "doped" with a valve grinding compound, and the ends of the grinding spindles are inserted into the slots of the valve heads. The springs *S* are "hooked up," and the machine is started. The grinding spindles rotate the valves, producing an abrasive action between the valves and their seats, and the cam levers *X* raise and lower the valves, allowing the grinding compound to work into the surfaces being ground. This method not only prevents the surfaces from becoming dry, but also distributes the abrasive in such a manner as to produce uniform and even results.

Fig. 3 shows the method used for boring cylinder holes and reaming push-rod holes in the upper half of the aluminum crank-case. The jig to which the upper half of the crank-case is fastened is bolted to the drill-press table. The table is moved to a position which brings the centers of the cored holes as nearly as possible in line with the center lines of the drill-press spindles. The machine is then started, the boring and reaming tools being fed by hand as shown. The cylinder holes are bored by the tools *T* and the valve-tappet holes by the reamers *R*. Two sets of holes are drilled in one operation, after which the drill-press table is moved over and the next set drilled in the same manner. This process produces absolute accuracy, as the center to

* For other articles dealing with tools and methods used in the automobile industry, see MACHINERY, August, 1911, "Machining Automobile Connecting-Rods"; October, 1910, engineering edition, "Making Automobile Radiators"; October, 1910, "Automobile Factory Practice," "Automobile Motor Testing Plant," "Machining a Motor Fly-wheel," and "Examples of Modern Turning Practice in Automobile Construction"; July, 1910, engineering edition, "Automobile Factory Practice—Olds Motor Works"; March, 1910, "Milling Fixtures for Automobile Parts"; January, 1910, "Making Accurate Automobile Engine Pistons"; January, 1910, engineering edition, "Automobile Factory Practice—Nordyke & Marmon Co."; December, 1909, "Manufacturing Automobile Equalizing Gears"; October, 1909, engineering edition, "Manufacturing Methods in the Stevens-Duryea Automobile Works," "Efficient System for the Rapid Assembly of Motor Cars," and "Treatment of Gears for Automobile Motors and Transmission"; October, 1909, "Automobile Factory Practice—The Dayton Motor Car Co."; June, 1909, "Machines and Tools for Automobile Manufacture"; May, 1909, "Special Automobile Factory Tools and Devices," and other articles there referred to. See also MACHINERY'S Reference Book No. 59, "Machines, Tools and Methods of Automobile Manufacture," and No. 60, "Construction and Manufacture of Automobiles."

† Address: 107 W. Walnut St., Indianapolis, Ind.

center distances of the drill press spindles are the same as the required center to center distances between the cylinders and the push-rods.

The holes for the squared ends of the live spindles of the rear axle in the axle dogs are produced by broaching, as shown in Fig. 4. The dogs are held in position by the hollow jig *A*, which is bolted to the base of the machine, the jig being slotted to conform to the teeth of the dog, as shown at *D*. The operation of the machine, which is of the worm-and-gear type, can be readily understood from the illustration. The dial on the column registers the pressure exerted in tons, the maximum allowable pressure being 30 tons. At *R* is shown one of the dogs after it has been broached.

The process used for reaming the holes for cam- and magneto-shaft bearings is rather unique. This work is ac-

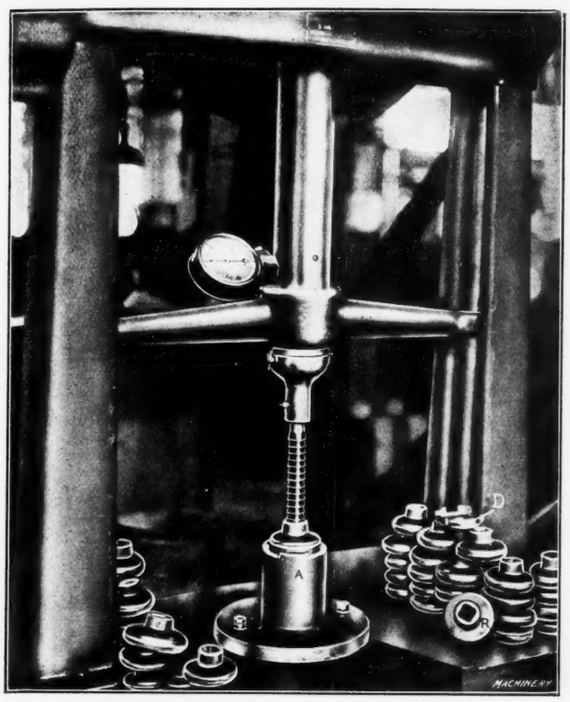


Fig. 4. Broaching Operation on Rear Axle Dogs

complished by means of a reaming fixture *F* bolted to the table of an open-side planer, as shown in Fig. 5. The reaming fixture is operated by the spindle *V*, which is connected to the gear box *D* by the coupling *S*. At *C* are shown spindles passing through the guide plate *H*. To the ends of these

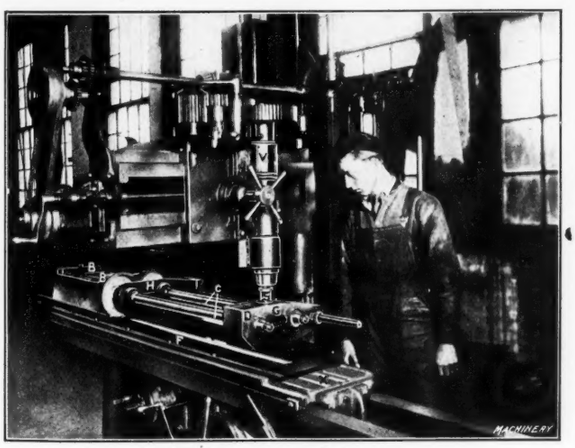


Fig. 5. Reaming Cam-shaft Bearings in a Crank-case

spindles are attached the fluted reamers. At *G* is placed a spiral driving gear which meshes with two spiral pinions on the spindles *C*. These gears are enclosed in the gear box *D*. The small spindle next to the operator is driven by a third pinion meshing with a gear on the right-hand cam-shaft reaming spindle, and is used for reaming the magneto-shaft bearing holes. The gear box *D* is so constructed that it slides freely in the guides at the sides of the base-plate, indicated in the illustration. The crank-case *W* is held in position by the clamps *B*.

The operation of the device is as follows: The machine is started, causing the gear *G* to revolve, which, in turn, revolves

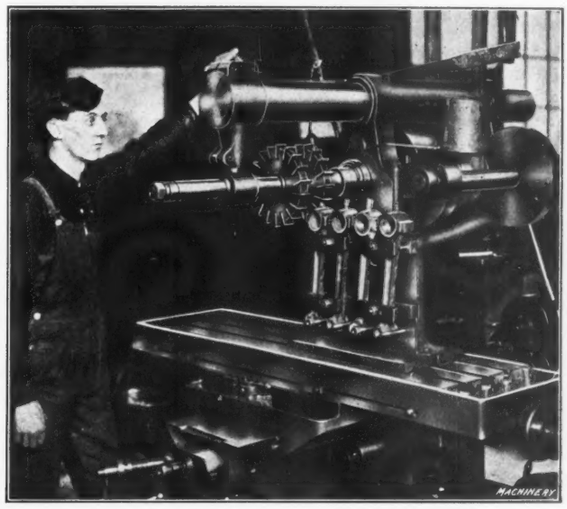


Fig. 6. Method of Facing Connecting-rod Stubs

the reaming spindles *C* and the spindle for reaming the magneto-shaft bearing holes. At the same time the planer table *X* is fed toward the operator, while the gear case, spindles, and reamers, remain stationary, except for their rotary motion. The transmission case, being fixed to the base-plate of the fixture, moves with the planer table. This causes the reamers to enter and pass through the bearing holes, from one end of the case to the other.

Connecting-rod stubs are faced in a milling machine as shown in Fig. 6, the rods being held during the operation in

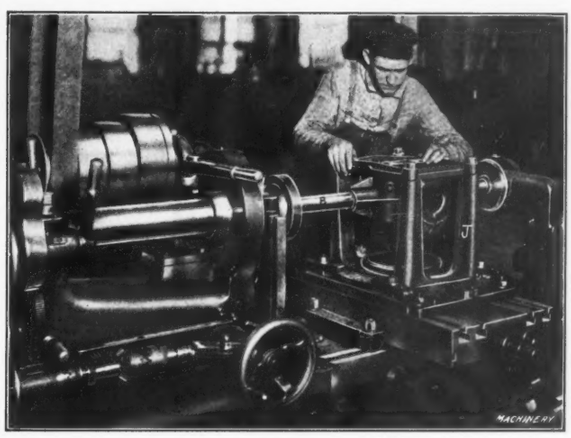


Fig. 7. Boring a Differential Case

the simple clamping fixture shown in the illustration. Both sides of the rods are faced in one operation by the two milling cutters, which prevents any variation in width.

The holes in the differential case, into which are brazed the live axle housings, are bored on a horizontal boring machine. The case is held in a special jig during this operation. Fig. 7 shows the boring machine and jig; *B* is the boring bar, *J* the jig, and *C* the differential case. The top plate of the jig is removable and has lugs on its under surface which hold the case in position while boring. The case is pressed against this plate by means of the handwheel at the bottom of the jig. The jig is clamped to its base instead of being made integral with it in order to allow a wider range of adjustment.

Jig used in Reaming Intake and Exhaust Valves

The reaming of intake and exhaust valves is an operation that requires unusual accuracy. The jig used for this purpose

is very interesting, and is shown in Figs. 8, 9 and 10. Fig. 8 shows the jig ready for use. Part *A* is a bushing for guiding the reamer (several different bushings are used to suit the various-sized reamers). At *B* is shown a hand screw for raising and lowering the flat plate on the lower side of the top of the jig. This plate exerts a downward pressure, while the adjusting screws *C* exert an upward pressure on the cylinders. By means of these screws accurate vertical alignment is obtained. At *F* is shown a turn-table which can be revolved on the base-plate *H* of the jig; *G* is a sliding plate on the turn-table, to which the cylinder is fastened by means of clamps *I* and *L*. At *E* is shown a plunger held by a spring, which prevents the turn-table from revolving; *K* is an adjusting screw for holding the slide *G* in the desired position. To revolve the turn-table, the plunger *E* is pulled back by means of the lever. Fig. 9 shows a pair of cylinders being inserted into the jig, and Fig. 10 shows the jig set up and bolted to the bed-plate of the drill press used in connection with the work.

When the reaming of one valve is completed, plunger *E* is pulled back, and the turn-table revolved until the next valve is brought into position, and so on, until all four valves have been reamed. The pair of cylinders is then released from the adjusting screws and clamps, and slid out of the jig in the same manner that it was put in.

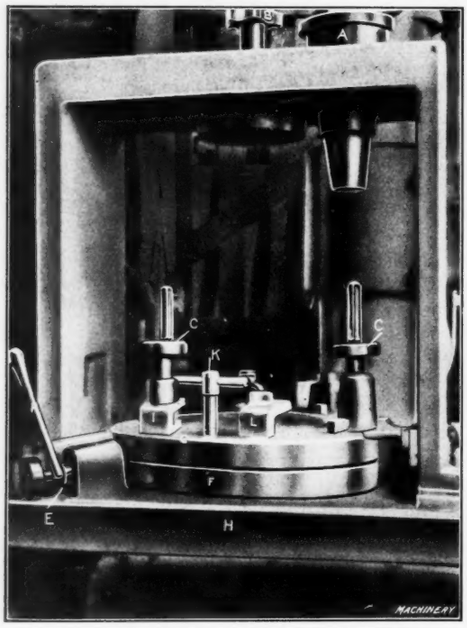


Fig. 8. Jig for Reaming Exhaust and Intake Valves

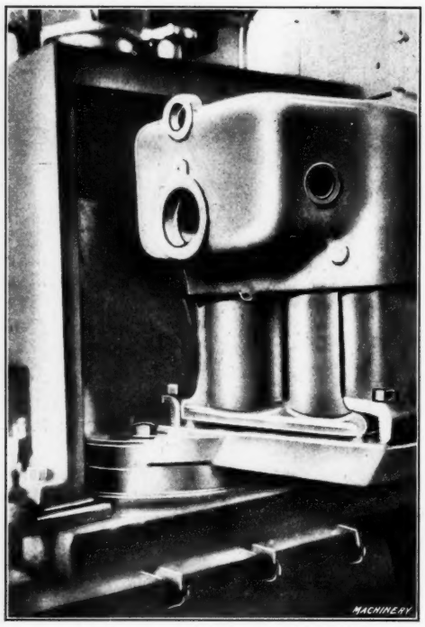


Fig. 9. Method of Inserting and Removing Cylinders

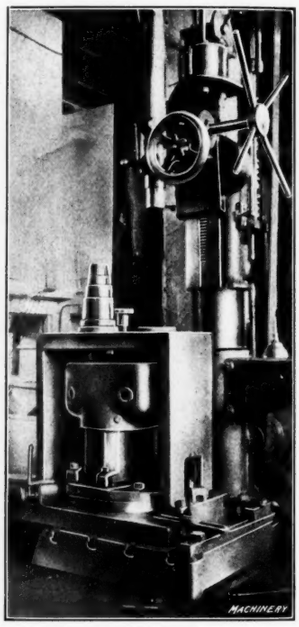


Fig. 10. Jig in Position in Drill Press

The foregoing tools and methods are of more interest from the standpoint of accuracy of results than from that of quantity of production. The machines described are so constructed that a very high degree of accuracy is obtained in the work turned out by them. Were increased production, with the same degree of accuracy, required, machines designed and built along the same general principles would probably produce the desired results. The machines, methods, jigs and fixtures described represent interesting examples of the successful means employed by a well-known company in converting rough forgings and castings into accurately finished parts.

* * *

According to a statement made in a paper read before the British Association for the Advancement of Science, the gyro-compass is now in use on a number of warships, and its installation on some of the large ocean liners is under consideration. Its advantage over the magnetic needle lies in the fact that it is not affected by large masses of steel, such as are used in the construction of battleships and other large vessels. The Anschutz gyro-compass, running on ball bearings, makes 20,000 R. P. M., and is driven by an induction motor whose armature forms the gyroscopic disk. The whole weight of the device is carried by a steel rim floating in mercury.

DON'TS FOR TOOLMAKERS

By WILLIAM YOUNG*

Don't leave a lapping block where it will be nicked or greased.

Don't forget that copper and cast-iron laps do not change in size easily.

Don't lap a piece of work continually in one place; keep moving it.

Don't use a steel plate for a lapping block; a cast-iron one is much better.

Don't forget that No. 1 diamond dust is the best for ordinary classes of work.

Don't forget that a lapping block with scored grooves is the best for flat surface work.

Don't forget that a boxwood lap charged with diamond dust is good for work which requires a high finish.

Don't forget when making ring gages to grind them within 0.0005 inch, leaving that amount for lapping.

Don't forget when lapping a hole to keep the work in motion so that the emery will not cut a groove in the work.

Don't forget when lapping a ring gage to cool it in benzine to the temperature of the plug and clean it before trying it on the plug.

Don't forget when lapping holes to always keep the work square with the lap to avoid the hole being irregular or bell-mouthed in shape.

Don't forget when lapping a piece of work on a lapping block that the pressure should be equally distributed, so as not to lap the work unevenly.

Don't forget that a good lap for accurate work can be made from copper or cast iron, which should be made a good running fit in the hole so as to lap the high parts.

Don't forget in lapping bronze or brass that crocus and Vienna lime freshly crushed and used on a hard wood or a lead lap gives a very good finish, but is slow.

Don't forget when lapping small holes that copper or Bessemer rod charged with diamond dust is very satisfactory, but should not be forced too much as they will strip easily.

Don't forget that a quick and cheap method of making a circular lap is to split a piece of wood and wrap emery cloth around it; but care should be taken to see that it fits the hole to be lapped.

Don't forget that it is good practice to leave a thin collar on each end of the hole in making a ring gage, so that the bell-mouthed portion produced in lapping can be ground off after the hole is lapped to size.

* Address: 13 River St., Rockville, Conn.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

ATTACHMENT FOR MACHINING ANGULAR FACES OF BEVEL GEARS

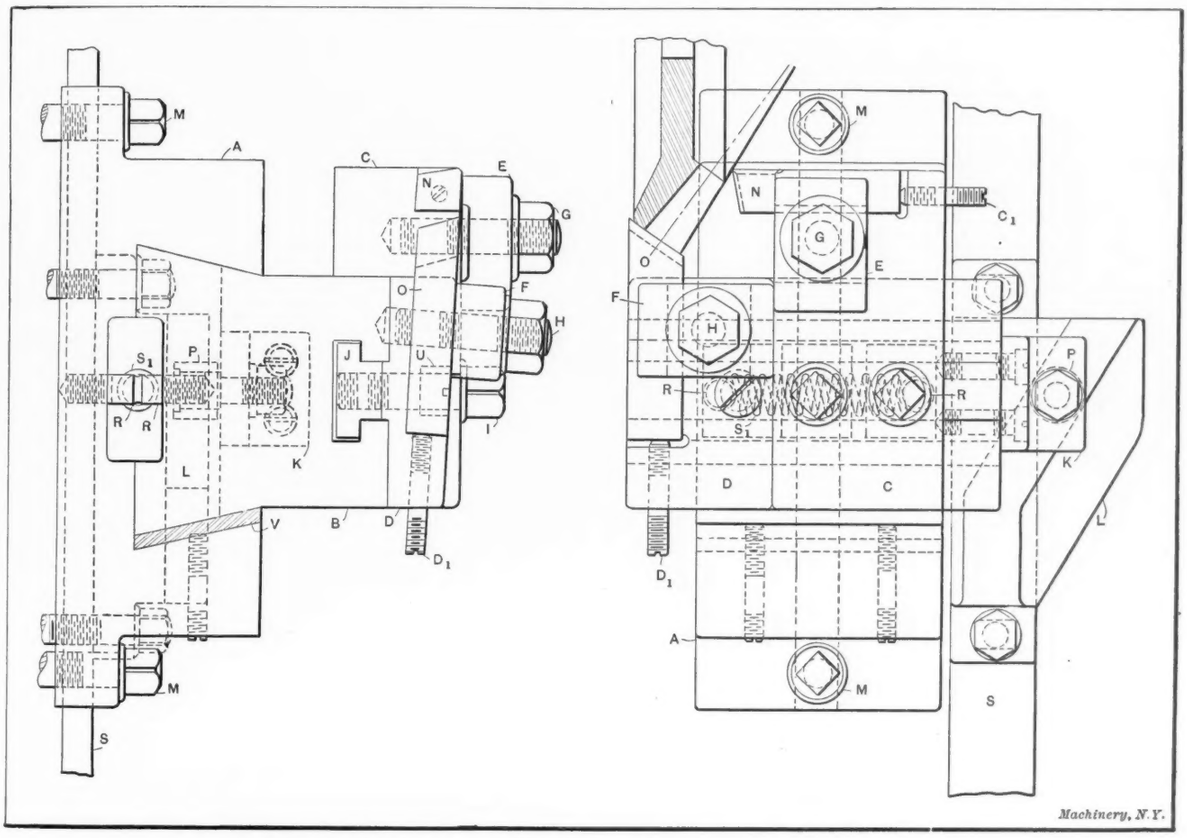
An attachment which can be used on any automatic turret lathe having a cross-slide is shown in the accompanying illustration. This attachment was used on a Gridley automatic turret lathe for machining the front and back face angles of bevel gears, and consists mainly of a base holding an adjustable member to which the turning tools are attached, this adjustable member being actuated by a guide.

The base *A* is fastened to the cross-slide by bolts *M*, while guide *L* is held to the cross-slide strap *S* as shown. The adjustable member or slide *B* is fitted in a dovetailed groove cut in the casting *A*, and is furnished with a gib *V*, to provide for wear. Attached to the sliding member *B* are two blocks. *C* and *D*, held to it by fillister-head screws *U* and T-nuts *J*. These blocks hold the turning tools, and are provided so that the tools can have a wider range of adjustment. The top face of the block *C* is milled out to hold the facing tool *N*, which is held with a clamp *E*, studs *H*, and nuts *G*. An adjusting screw C_1 tapped into the block is used for adjusting the tool. The back facing tool *O* is set in a milled seat in the block *D*, and is held with a clamp *F*, studs *H*, and nuts *G*, being adjusted by screw D_1. A bracket *K* attached to the slide *B* by fillister screws, carries the roll *P*, which slides in the groove cut in the guide *L*. The tools are kept in contact with the work by means of a spiral spring S_1, attached to studs *R*, one of which is screwed into the movable slide *B*, while the other is screwed into the base. These studs are provided with grooves, as shown, in which the rings on the end of the spring fit.

In operation, as the cross-slide travels forward, the roll *P* moves in the guide *L*, thus drawing out the slide *B*. This guide is provided with the same angle as the angle required on the face of the gear, so that as the cross-slide travels in, the front face is machined to the correct angle by means of the cutter *N*. As soon as the front face is finished, the cutter *O* comes in contact with the back face of the gear, and finishes it; then as the cross-slide retreats, the slide *B* is returned to its former position by means of the spring S_1 and guide *L*. The turning tools *N* and *O* are made from Novo Superior tool steel, which has been found to give very satisfactory results for machining cast iron and steel. The tool *O* has to be ground to the angle required on the back face of the gear, while the tool *N* is only ground to provide for clearance. This attachment can be used for turning other face angles simply by changing the guide *L*, and the angle on the cutter *O*.

HAROLD E. MURPHEY

Westerly, R. I.



Attachment for Machining Front and Back Faces of Bevel Gears in an Automatic Turret Lathe

ECCENTRIC TURNING DEVICE FOR AUTOMATIC SCREW MACHINE

The writer has seen several articles in MACHINERY concerning work done on the automatic screw machines, and contributes the following article with the hope that it will be of interest to the readers. The eccentric turning attachment shown in Fig. 2 was made for a No. 1 Hartford automatic screw machine. The piece for which this attachment was made is shown in Fig. 1, and is called a "spooler gear stud." It is used to adjust the spooler gear to the worm on the end of the spooler spindle of a Davis sewing machine. The threaded body of this spooler gear stud is 0.025 inch eccentric with the rest of the piece and it is entirely completed in the turning attachment shown in Fig. 2.

The turning attachment comprises a special spindle *A*, practically the same as the regular machine spindle with the exception that the front end is turned ⅛ inch eccentric with the bearings and is made to hold a special hood *B*. A 3/16-inch groove is cut in the nose of the spindle and also in the hood in which a chain of 3/16-inch balls is placed, a hole being drilled through the side of the hood for the insertion of these balls, which act as a friction lock between the spindle and

hood, allowing the latter to turn freely when necessary. A depression is cut in spindle *A* for the key *C* so that the latter acts as a stop to prevent the hood from turning completely around on the spindle, the hood having an annular groove cut in it which allows an angular movement of the hood of about 20 degrees. When the key *C* is against one end of the slot in the hood, the chuck *E* is in the eccentric position, and when it is against the other end of the slot, the chuck is in the

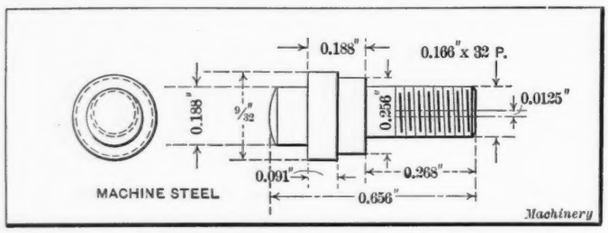


Fig. 1. The "Spooler Gear Stud" made with the Attachment shown in Fig. 2

concentric position. The hood *B* is made a good fit on the end of the spindle, both the hood and the spindle being hardened, ground and lapped to size.

The hood *B* is bored and tapped to receive a bushing *D*, which holds the chuck *E* in position. The hole in the bushing *D* is bored concentric with the bearings of the spindle *A*, making it possible to use an ordinary spring collet. The rear end of the bushing *D* is slotted to fit a projection on the chuck *E*, so that the latter will be held in the same position in relation to the hood at all times. An ordinary ball bearing *F* is used between the chucking rod and the chuck *E*, to give an easy movement when shifting from the concentric to the eccentric position.

A bracket *G*, fitted to the front side of the spindle head, holds two swiveling fingers *H*. The swiveling fingers are fitted with steel pads *I*, so that when they are drawn together on the steel ring *J*, which is fitted to the hood *B*, they act as a friction grip for shifting the hood from the eccentric to the concentric position. The rear ends of the fingers *H* are beveled to fit the cone-pointed adjusting screw *K*, which is fitted into a block *L* held on the front cross-slide, this block *L* being operated by cams on the front cross-slide disk. The cone-pointed screw *K* is used to adjust the tension of the steel

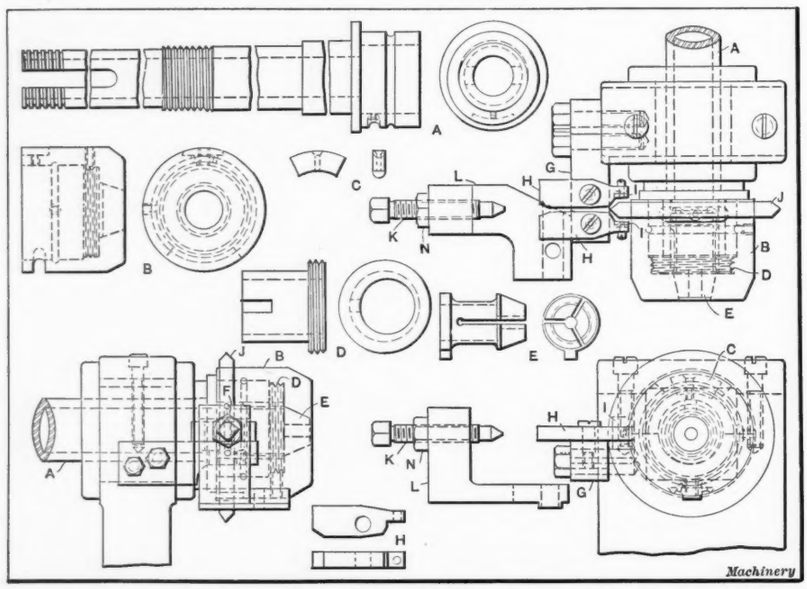


Fig. 2. Assembly and Detail Views of Eccentric Turning Device for Hartford Automatic Screw Machine

pads *I* on the steel ring *J*, and when the proper tension is obtained it is locked by nut *N*.

The order of operations for completing the piece shown in Fig. 1, is as follows: First, feed stock out to stop and shift hood *B* from eccentric to concentric position, while the machine is "unchucked"; second, form with form tool on rear cross-slide with spindle running backwards, cutting off preceding piece and forming new piece; third, finish shoulders to size and length with box-tools; fourth, bring pads *I* in contact with ring *J* on the hood *B* with spindle running forward, and force hood *B* to the eccentric side of the key *C* (Special cams on the rear cross-slide drum partly "unchuck" the machine, so that the hood *B* will move easily on the spindle to its position against the key, care being taken to have sufficient tension to hold the work in position. Another cam placed on the rear drum shifts the chuck until it is under its original tension); fifth, rough-mill forward and true up eccentric threaded body; sixth, finish-mill threaded body to size and true up shoulder; and seventh, thread.

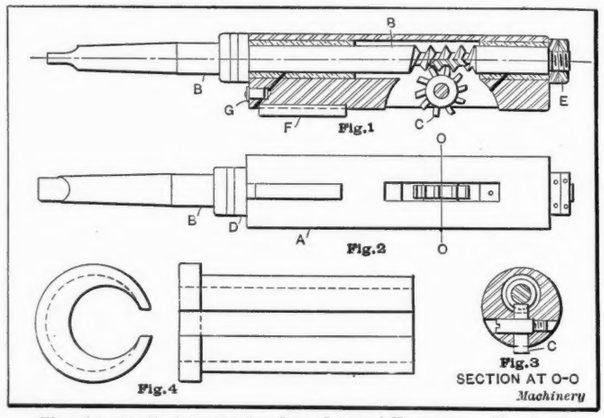
This attachment has been in constant use for over three years, and has been turning out an average of 700 pieces per day without any trouble.

MICHAEL T. BYRNE

Dayton, Ohio.

TOOL FOR CUTTING LONG INTERNAL KEYWAYS

The accompanying illustration shows a tool made in our shop for cutting long internal keyways, which has given satis-



Figs. 1 to 3. Tool for Cutting Long Internal Keyways. Fig. 4. Slip Bushing for Use when the Hole in the Work is Larger than the Body of the Tool

factory results. The tool consists of a machine-steel body *A*, bored out and bushed to receive the spindle *B*. A recess is cut in one side of the body as shown in Figs. 1 and 2, to receive the cutter *C*. The spindle *B* is made with a coarse-pitch thread of the proper size to engage with and drive cutter *C*. The upper end of the spindle is turned to fit a standard drill press socket, although, of course, this may be varied to suit requirements. The cutter *C* is made by cutting the blank with a small gear-cutter and grinding one side of the teeth to the proper shape. Suitable pressure collars are provided at *D* and adjusting nuts at *E*. A guide key *F* is staked in place to insure the tool cutting a straight keyway. Suitable means for oiling the spindle and cutter are provided, as shown in Fig. 1, a handy oiler being placed at *G*, and oil holes in other places.

In operation, the tool is used in an upright drill press and feeds into the work as in drilling. The body, of course, must be a neat fit for the hole in which the keyway is to be cut, to insure good work. When cutting keyways in a hole larger in size than the body, the bushing shown in Fig. 4 is used. This bushing is bored eccentric and has a shoulder for convenience in holding. When the tool is running hard, and shows a tendency to twist, a clamp may be put on near the top of the device until the guide key has passed into the cut portion of the new keyway.

Hamilton, Ohio. J. B. HASKELL

CONVENIENCES FOR THE DRAFTING TABLE

Frequently the application of an inexpensive improvement or appliance to one's work will result in a saving of time and expense. No doubt every draftsman has experienced the inconvenience of lettering near the bottom of a large drawing which covers the entire drawing-board, without some means of supporting his elbow. Fig. 1 shows a drop leaf or wing, about 10 inches wide by 13 inches long, which is attached to the drawing-table, and provides a rest for the arm. When not in use it can be folded beneath the table out of the way, as shown by the dotted lines. This device has the further

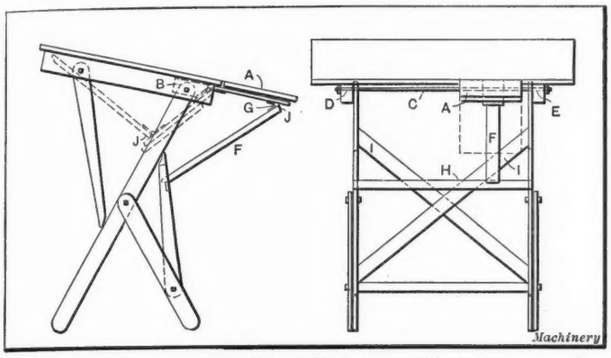


Fig. 1. Drafting Table provided with an Elbow Rest

advantage of being adjustable to any position along the lower edge of the drawing-board, as it is made to slide on a rod *C*, thus allowing it to be placed in any convenient position.

The wing *A* is hinged to a block *B*, which slides on the rod *C*, the latter being made from cold-rolled steel and threaded on both ends, on which nuts are screwed. This rod takes the place of the bolts which were originally provided at *D* and *E* for holding the table together. A leg *F* hinged at *G* rests on the cross bar *H* and supports the outer end of the wing. When folded beneath the table, the wing is moved over near the side and allowed to rest on the braces *I* which hold it in

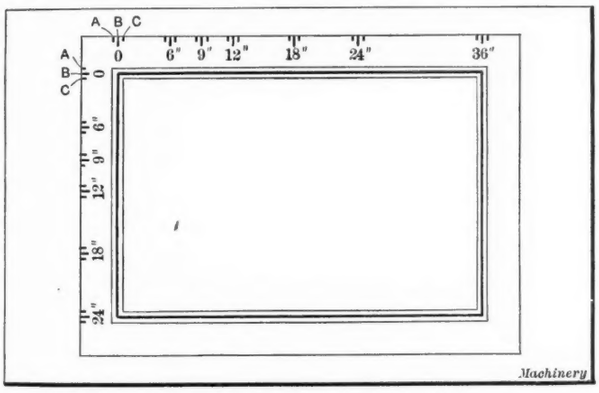


Fig. 2. A "Graduated" Drawing Board

place. The end *J* of the leg *F* is so trimmed that when the wing is folded, the opposite end of the leg will not project past the drawing-board and interfere with anyone passing. This wing *A* also serves the further purpose of providing a place to rest the points of the beam compass or other instruments when drawing large curves or circles, the centers of which would not come on the drawing-board.

Fig. 2 is a top view of what might be called a "graduated" drawing-board, the graduations being used to indicate the dimensions of standard drawings. Each graduation *A*, *B* and *C*, consists of heavy lines, of which *B* is longer than the other two. The graduation *A* indicates the trimming line of the sheet, *B* the border line, and *C* the drawing line of the limit for the drawing proper.

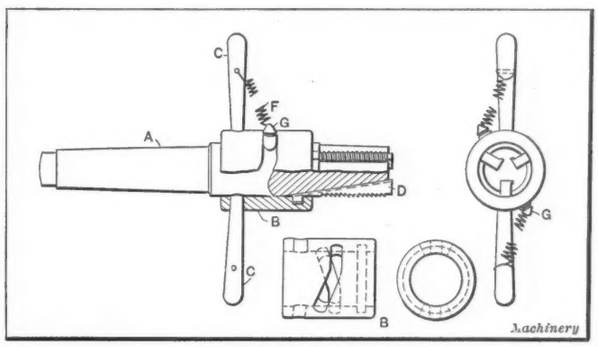
In use, the sheet is tacked to the drawing-board, and the border lines drawn, after which the trimming line and the inside or drawing lines are drawn in lightly with pencil so that they can be erased. The drawing lines *C* are simply to serve as a guide for keeping the drawing the proper distance away from the border line. The board shown in Fig. 2 is laid out for drawings from 6 by 9 to 24 by 36 inches. Of course, it is needless to say that any set of standard dimensions may be laid out as required. The advantage of this method lies in the fact that it does not necessitate measuring a drawing to see that it is of the correct size.

Aurora, Ill. E. J. G. PHILLIPS

A COLLAPSING TAP

The accompanying illustration shows a collapsing tap designed and furnished by a tap and die concern for the purpose of tapping a 1-inch Briggs standard pipe thread in cast iron, using a semi-automatic machine. The tap was designed to collapse on account of the desirability of withdrawing it without running out, thus decreasing the wear on the tap and increasing the production.

Referring to the illustration, *A* is the taper shank holder; *B*, the cam sleeve; *C*, the handle used as the knock-off; *D*, the blades of the tap; and *G*, a stud fastened to the taper



An Efficient Collapsing Tap

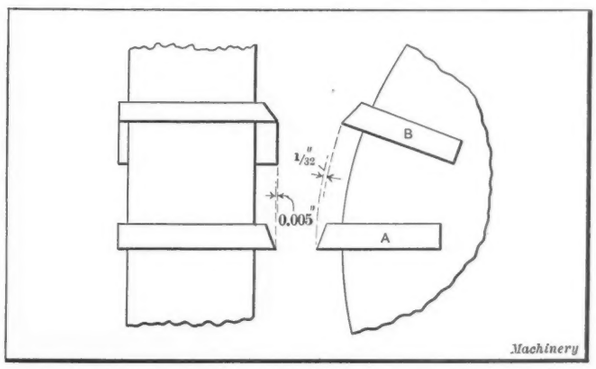
shank holder, to which the spring *F* is fastened at one end, the other end being fastened to the handle *C*.

In operation, the handle *C* is held by the spring *F*, so that the blades *D* are drawn up on the taper and expanded to the correct size. The tap in action feeds in until the handle *C* strikes the stop, advancing the cam sleeve *B* through the action of the cam slot on the stud *G*, thus throwing the blades forward on the taper and collapsing the tap.

Hartford, Conn. F. CHARLES SCRIBNER

FACE MILLING CUTTERS FOR FINISHING

It is almost impossible to obtain a good finish when milling a rough surface with a face mill, without taking an extra finishing cut. This is not always permissible, because of the time consumed in re-handling the work. The roughness is



Method of Grinding the Blades of Face Mills to produce a Smooth Finish

the result of the cutting edges of the blades being nicked and burred, because of the comparatively heavy service required of them in removing the stock.

It occurred to the writer that if some of the blades could be used only to take a light cut in clean iron, the difficulty would be largely overcome. This was accomplished by grinding the mill as shown in the accompanying illustration. Blade *A* is used for roughing. It projects 1/32 inch farther from the body of the mill than the finishing blade *B*, directly behind

it, while at the same time it does not take as deep a cut as blade *B* by 0.005 inch. Every alternate blade is ground the same as *A*, and the remainder of the blades are ground like *B*.

It is evident that the scale and most of the stock will be removed by the roughing blades, while the finishing blades only take a light cut 0.005 inch deep, and hence keep a smooth edge and produce a good finish. This method of sharpening face mills does not take much longer than grinding the blades all the same, but it materially increases the number of pieces which can be milled before re-sharpening. R. W.

TOOLS FOR A TYPEWRITER FEED-FINGER

The front feed-finger of a Fay Sholes typewriter, shown a *A* and *B* in Fig. 1, is a piece of work which requires great accuracy in the tools, so much so that the methods of manufacturing it should be of interest. The blank as shown at *A*, was cut out by the punch and die shown in Fig. 2. This die is made sectional, that is, it is made of two pieces *A* of hardened tool steel, which are inserted in machine steel die-block *B*. This form of die construction permits of great economy in working out the shape, as the greater part of the stock can be removed with a milling cutter.

The stop in this die is of improved construction and varies from the finger stops usually made, which have a tapered hole reamed in them and swing on a pin let in from the side

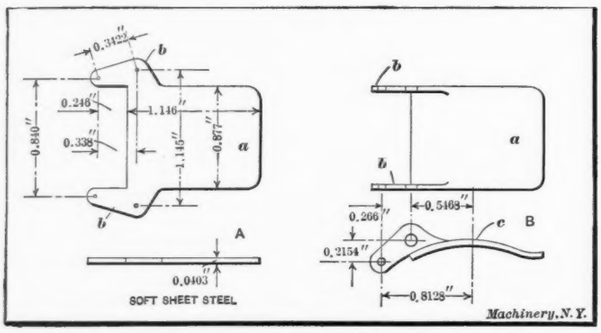


Fig. 1. Front Feed-finger for the Fay Sholes Typewriter, before and after Bending and Piercing

of the die. The tapered hole in the finger allows only for a small bearing on the pin, and the up, down and sidewise movement of the stop results in wear which soon destroys its accuracy as a locating point. The stop *C*, shown in Fig. 2, bears on a pin *D* which gives a bearing the full width of the stop. The pin *D* is held in a slotted disk *E*, which is located in a hole in the stripper, and is prevented from coming out by two round-head screws *F*, the heads of which overlap the

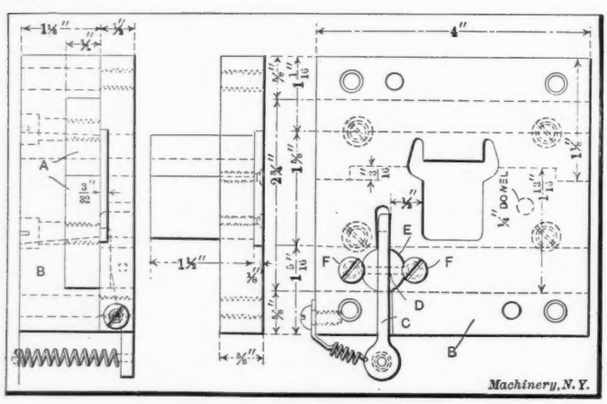


Fig. 2. Blanking Punch and Die

disk. The disk *E* is made a turning fit in the hole and a good bearing is thus obtained.

The punch and die for bending the typewriter feed-finger into the shape shown at *B*, Fig. 1, is shown in Fig. 3. The piece to be bent is located by the set edges *A* and rests on the pad *B*, the latter being shown in its "down" position. The part *a* of the spring, Fig. 1, is formed, and the ears *b* are bent at right angles, as shown at *B*, in this die. The pad *B* (Fig. 3) is raised by a spring-pressure device, and the piece is thus lifted out of the die after being bent. The punch *C* is cut away to allow the ears to lap beside it, as shown at *D* in the illustration.

As the location of the two pierced holes in the ears, shown at *B* in Fig. 1, required to be accurate in relation to the sur-

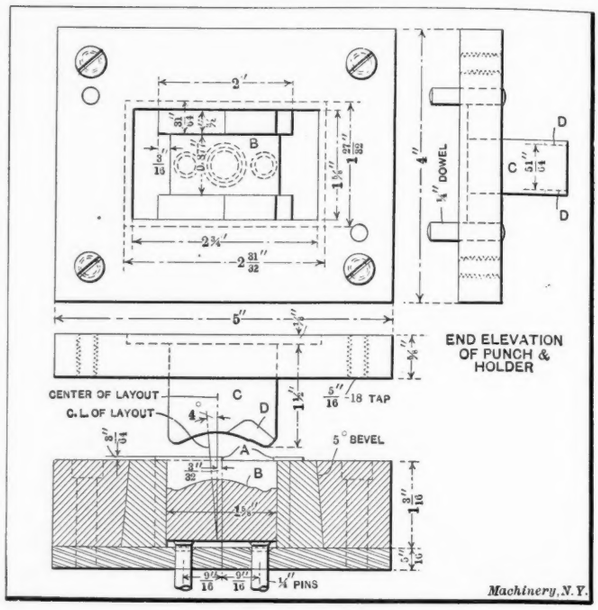


Fig. 3. Bending Punch and Die

face *c*, it was found impracticable to pierce them before bending, and on account of the shape of the work a rather elaborate locating device is used in the piercing die shown in Fig. 4. A swinging hinge *A* which turns on the pin *B* is used as a locating nest for holding the work while the holes are being pierced. The work is located between the gage-plates *C*, and one end bears against the stop-pin *D*, while the other end is held by the snap-catch *E*. The hinge *A* is closed

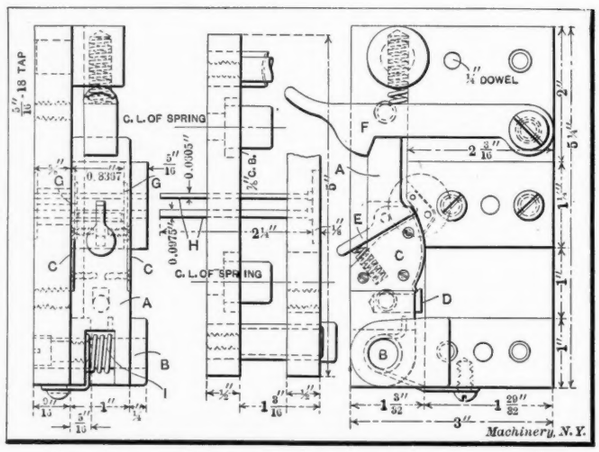
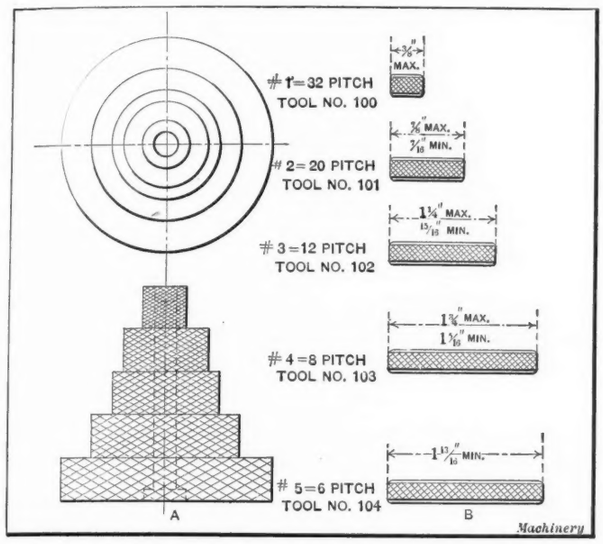


Fig. 4. Piercing Punch and Die, which embodies an Interesting Locating Device

against the die and the snap-catch *F* holds it in position. The two ears on the work fit into slots *G* cut in the die. The holes in the top ear are pierced by the punches *H* and the slugs from these holes precede the punches through the lower ear. This may appear to some as a rather unusual proceeding, but the method has been used with success in the Fay Sholes factory on different pieces requiring exact alignment between the holes; it has also proved superior to drilling for this purpose. When the piercing operation is completed the die is cleared by releasing the snap-catch *F*, when the swinging hinge *A* flies back owing to the tension of the spring *I*. The piece is then removed by releasing the small snap-catch *E*. DESIGNER

KNURLING STANDARDS

Trouble is frequently experienced in factories where knurling operations are performed from having the wrong pitch of knurling applied to a given diameter of work. This trouble was overcome in one large factory by furnishing the heads of each department as well as the designers and draftsmen, with a blueprint upon which were designated the maximum and minimum diameters for which each pitch of knurling was applicable, giving the pitch of the knurling a number, and specifying the tool number of the knurls to be used.



Knurling Standards furnished to the Heads of the Various Departments, and Knurled Paper Weight given to Designers

On prints of manufacturing parts issued from the drawing-room, were specified the number denoting the pitch of the knurling required and the tool number of the knurls used to produce it. The standards furnished to the heads of the various departments are shown at *B* in the accompanying illustration and a paper-weight, which is given to each designer, is shown at *A*. This shows each step knurled, and the maximum diameter for that pitch of knurl.

Hartford, Conn. F. CHARLES SCRIBNER

PRICES OF JOB WORK DONE ON MACHINE TOOLS

The article "Prices of Job Work Performed on Machine Tools," which appeared in the October, 1911, number of MACHINERY, engineering edition, opens up a subject which merits considerable discussion. In this article various hourly rates for work done on machine tools are quoted, varying from $0.20 to $1.50. Although not so stated, the writer assumes that, with a possible exception of the items given for the Rockford shops, the direct labor or time of the operator is included. A study of the various factors that enter into the question of maintaining and operating a machine tool will, the writer believes, lead to the conclusion that a more just and equitable rate for the machines involved should be devised, than the absurd flat percentage rate based on the direct labor so customary throughout the country.

To illustrate this the writer will outline the foundation of a machine rate based on his views. The ideas are not submitted with the opinion that they give a complete basis for the charge for machine tools, but rather with a hope that a discussion will be started on machine tool rates in general which will add useful information on this subject.

The machine rate is composed of two principal parts, the cost of the floor space that the machine occupies, and the cost of tools, supplies, power, etc., consumed by the machine. The first we will, for convenience, call building items, and the latter, machine items. All the factors entering into these items should be computed on an annual basis, which will make it comparatively easy to compute the hourly charge for each machine.

The building items should consist of the following factors:

1. Land, consisting of interest on the capital invested therein, the taxes, care of grounds, etc.
2. Buildings, consisting of interest on the capital invested, taxes, insurance, annual depreciation, care, watchmen, repairs, etc. In the case of a rented shop the foregoing items would be covered by the annual rent.
3. Fixtures, consisting of the interest on the capital invested in shafting, belting, motors, power plant, etc., and the depreciation, repairs, supplies and labor incident thereto.
4. Heat, being the interest on the capital invested in the plant, radiators, etc., and the depreciation, repairs, coal consumed and the necessary labor employed.
5. Light, consisting of the interest on the capital invested in dynamos, wiring, lamps, etc., and the depreciation, repairs, supplies, and labor employed.

In many shops the factors of power, heat and light are so closely interwoven that it is not practical to try to segregate them, and in this case they can generally be combined under one head without in any way departing from the principle involved.

The machine items should consist of the factors of interest and depreciation, repairs, stores, tools, superintendence, inspection, planning, and power consumed by the machine in question. To properly apportion these several expenditures over the machines concerned, the building items should be considered as a function of the floor space occupied by the machine. It is evident that there will be floor space in the shop that cannot be equitably charged against any individual machine—such as offices, aisles, stock rooms, etc. That occupied by a toolroom, inspection department and planning room, if any, should properly be charged under those respective heads, independent of the machine, as it is evident that these items might have no relation whatever to the space occupied by the machine. For instance, take the case of a large boring mill occupying 200 square feet of floor space and of a No. 3 horizontal milling machine occupying 75 square feet. It is evident from even a casual inspection that the milling machine will require a larger expenditure for tools, and also for inspection, as it requires about as much time to inspect a small piece as it does a large one; and in the time required to do a large job on the boring mill, several small jobs or pieces will be completed on the milling machine.

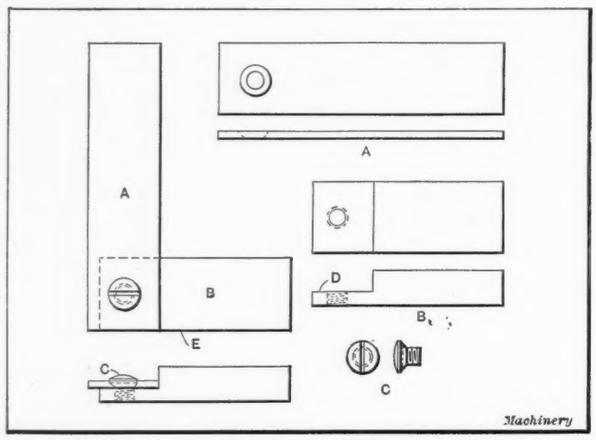
The space actually occupied by each machine should be measured and to it added sufficient space for the workman and the material being, and to be, worked on. To the sum total of the spaces thus used should be added the space occupied by the toolroom, inspection department and planning room, and the amount thus obtained should be taken as the total area of the shop instead of the area that would be obtained by computation from the actual dimensions of the shop. In this way the unoccupied space is spread uniformly over all the machines. The total of the building items divided by the computed area will give the annual cost per square foot of the shop space, and the cost thus obtained per square foot of floor space times the space occupied by any particular machine would be the proper charge per hour for that machine, exclusive of the direct labor. T. COVEY

MAKING A HARDENED TRY-SQUARE

In the January, 1911, number of MACHINERY appeared a request for information regarding the making of accurate hardened try-squares, and in the March and April numbers, two articles were published describing the making and the means of testing such squares.

Another type of try-square which has been found reliable, is easily made, and possesses the advantage that it can be taken apart and trued up, is shown in the accompanying illustration, assembled and in detail. The hole in the blade *A* is drilled and countersunk slightly larger than the body of the screw *C*, and the position of this hole is off center, so that the head of the screw bears against one side of the countersunk hole, drawing the blade firmly against the stock *B*, The stock and blade are machined somewhere near the required size, the hole drilled and tapped in the stock, and drilled and countersunk in the blade. The blade and stock are then hardened as is also the screw *C*. The length of time for which the blade and the stock are allowed to season will govern the reliability of the square to a large extent.

After seasoning, the stock is ground square and parallel, care being taken to make the shoulder and face *D* as true as possible, using a square-cornered saucer wheel. The shoulder and face *D* are finished by lapping to get a true and dead smooth surface. The method of lapping and testing a try-square was described in the articles previously referred to. The blade is now ground square and exactly parallel, and finished by lapping. The stock and blade are then fastened together, and the outside edge of the blade and also the sides of it are tested for accuracy. The bottom face *E*



A Hardened Try-square which can be easily and cheaply made

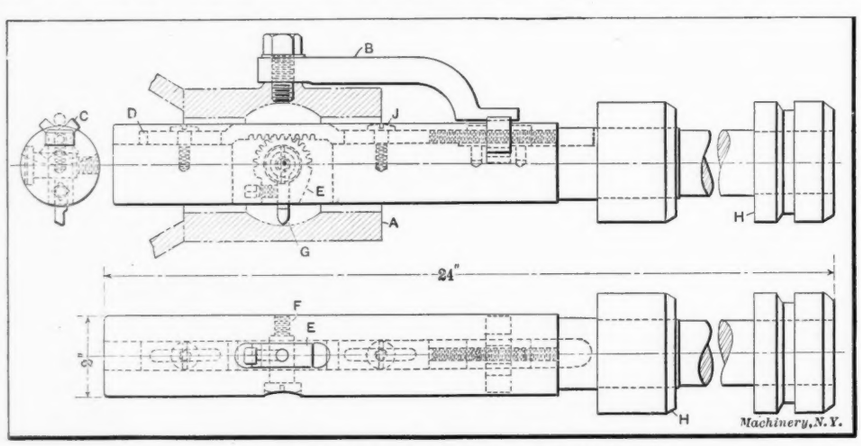
of the stock is then ground and lapped dead parallel with the side.

If care has been taken in making the blade and stock, it will be found to be accurate when assembled. The sides of the blade will also be square with the stock, which is a feature usually absent in the ordinary square, when the blade is sweated in. A square of this description, if correctly made, is practically a knife-edge square, as both edges and sides of the blade are square with the stock, so that the corners of the blade can be used. If a knife-edge square is desired, it can be easily made in the same way. For ordinary machinists' use, this type of square can be finished on the surface grinder, producing a good hardened square at a much lower price than that at which they can be purchased.

JETHART

A SPHERICAL BORING-BAR

The accompanying illustration shows a boring-bar which was designed for boring a spherical recess 3 inches in diameter inside a cylindrical hole 2⅛ inches in diameter. The spherical recess had to be bored a given distance from the top face down in the cylindrical hole of the casting *A*. Casting *A* is held in a special fixture on a small vertical boring-



A Spherical Boring-bar for Use in the Boring Machine

mill table. After boring and facing the cylindrical hole in the usual manner, the boring-bar is inserted in the boring-mill head, and the arm *B* made fast to casting *A* by one cap-screw, placed in a tapped hole which was already in the casting.

In operation, as the casting *A* is fastened to the boring-mill table, it revolves about the bar carrying the arm *B*, which engages with a star-wheel *C*, causing the latter to revolve one-quarter of a turn for every revolution of the casting. The star-wheel *C* fits snugly in a slot, and has a tapped hole in it. Fitting in the tapped hole in the star-wheel is the threaded end of the rack *D*. Since the star-wheel *C* is confined, as to side play, and the arm causes it to revolve, the result is the movement of the rack in a direction parallel with the center line of the bar. Rack *D* engages with tool-holder *E* on which are cut teeth of corresponding pitch.

This longitudinal motion of the rack causes tool-holder *E* to revolve on the central pin or shaft *F*, carrying with it the tool *G*. Tool-holder *E* is a snug fit in a slot in the bar, and also a running fit on the central shaft *F*. It is, therefore, obvious that these combinations of motion give a spherical recess. The rings *H* were shrunk on the bar, and are a snug fit in the boring-mill head. This was simply to keep the bar as light as possible. The screws *J* are to keep the rack *D* from rising out of the slot in which it slides. This is a rather unusual tool, but the principles involved may assist in the designing of a similar tool for a different purpose.

S. B. ROOK

CUTTING AN ODD NUMBER OF CLUTCH TEETH

In a small shop where a variety of work came in, we at one time had to cut some jaw clutches. Both the milling

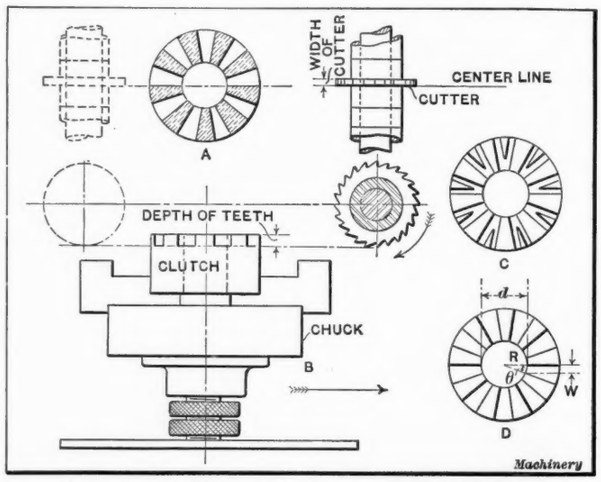


Diagram used in Setting Cutter to cut a Jaw Clutch having an Odd Number of Teeth

machine hand and the foreman could not see why the draftsman called for an odd number of teeth. They had cut an even number of teeth before the firm established an engineering department, and they could not see the advantage of cutting an odd number of teeth. However, they went ahead and cut an odd number of teeth, but spoiled the work by using too wide a cutter. To avoid future mistakes like this, the draftsman prepared a diagram as shown in the accompanying illustration. The instructions given for cutting an odd number of teeth are as follows: Set the cutter to the inside of the center as shown at *A*, or in other words, set the outside face of the cutter in line with the center of the work. Then index the number of teeth desired and cut around twice, which will leave the clutch as shown at *C*. All that is necessary now is to cut away the remaining webs between the teeth. The widths of the cutter to use for cutting any odd number of teeth are obtained by the following

formulas: $W = 2R \frac{\sin \theta}{2}$ $\theta = \frac{360}{2N}$

where

W = width of cutter,

R = radius of bore or $\frac{d}{2}$ (see D)

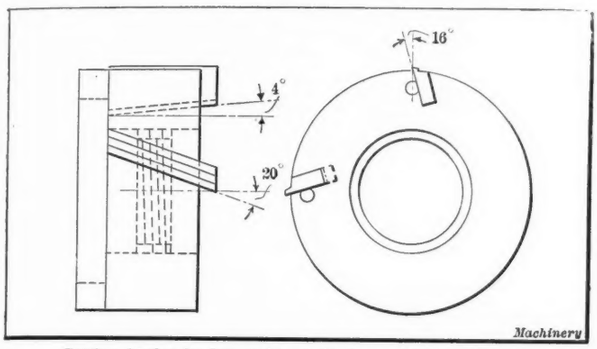
θ = included angle of tooth space,

N = number of teeth.

North Emporia, Va. GEORGE M. MEYNCKE

SETTING ANGLES FOR INSERTED-TOOTH HIGH-SPEED MILLING CUTTERS

The accompanying illustration shows the angles at which the inserted teeth in high-speed milling cutters should be

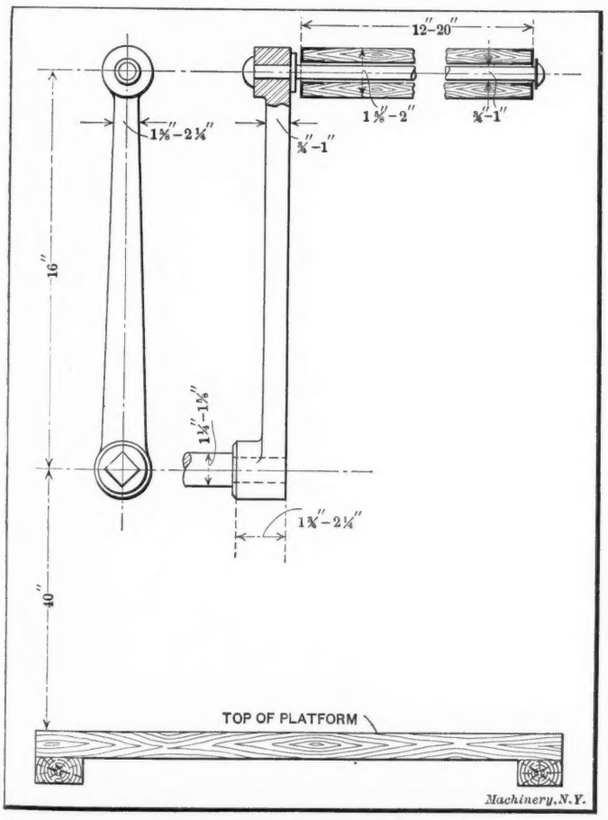


Setting Angles for Inserted-tooth High-speed Milling Cutters for Heavy Duty

set to give good results. A cutter made as shown, 6 inches in diameter with 12 teeth and operated at 224 R. P. M., with a feed of 9¼ inches per minute, is doing excellent work, roughing and finishing forged copper in a vertical high-speed milling machine. COPPER

PROPORTIONS OF HAND-CRANKS

The accompanying illustration gives dimensions for hand-cranks as applied to hand-operated cranes, winches, etc. It



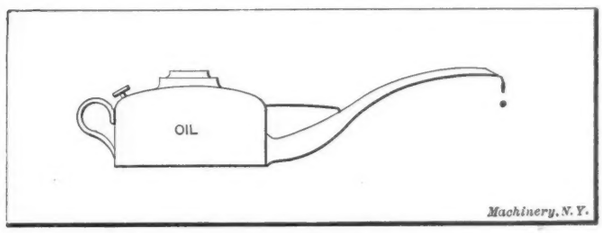
Proportions of Hand-cranks—Where Two Dimensions are given, the Larger is for Cranks operated by Two Men

will be seen that two sets of dimensions are given for the proportions, the larger dimensions being for cranks operated by two men, while the smaller are for cranks operated by one man. The distance from the shaft of the crank to the top of the platform on which the operator stands should be 40 inches as shown. The average force that one man can exert on a crank may be assumed to vary between 20 and 30 pounds. At intervals, as much as 40 pounds is a fair assumption. The circumferential speed varies usually from 20 to 40 inches per second. These values are based upon an 8-hour work-day. Cranks proportioned as shown have been used for a long time with entire satisfaction. F. J. B.

FRICTION ELIMINATED

It was at one of the technical institutes in the north of England during the session just passed, that the head of the mechanical engineering department gave a two-hour lecture to a class of applied mechanics, students of the average age of eighteen, upon different devices, etc., for the reduction of friction. A few weeks afterward, the lecturer gave them for home work among other requirements the following: Sketch and describe fully any mechanical contrivance you know of for the elimination of friction.

This is the answer one of the students sent in: "The above sketch (see illustration) represents a contrivance which is



Friction Eliminating Device

made of tin, to hold a liquid called oil, the application of which is all that is necessary to make one part of a machine slide easily over another." A. PIERCE

PIERCING CAST IRON IN POWER PRESSES

The letter on piercing cast iron in power presses, which appeared in the September, 1911, number of MACHINERY, interested me very much, as we have been piercing cast iron for the past two years. The reason for piercing the holes was that the cast holes did not come accurate. The casting has a flange around it, but the part to be pierced is about 0.080 inch thick. Two holes are pierced about ½ inch apart, one of which is nearly square and the other round; the latter is about ⅝ inch from the edge of the casting. The castings are japanned before assembling.

We found that the shape and condition of the die did not make so much difference in regard to the cracking of the casting as did the shape of the punch. The dies used were perfectly flat on the top. If the punch is not backed off to within 1/64 inch of the cutting edge it will crack or break the casting nearly every time. The cutting edge of the die has been worn off and very few castings will crack or break as long as the punch is in good condition. The punches usually have to be ground three or four times to one grinding of the die.

The castings are usually good, but they vary; one batch will work fine and perhaps the next batch will cause all sorts of trouble. For instance, not long ago we ran through a batch which to all appearances was perfect; no crack was to be seen and they rang clear, but when taken out of the japanning oven every one showed a crack extending from the round hole to the edge of the casting. The piercing must have caused a slight strain, which was not sufficient to crack the castings until they were heated in the oven, for we found that by holding a casting over a blow-pipe, it would snap at a certain temperature. We are satisfied with the results, however, and hope this information may be of value to others. J. M. L.

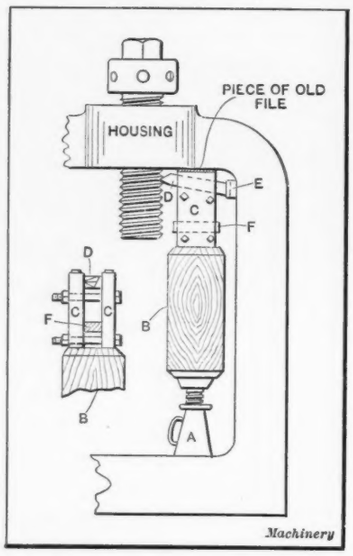
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this department. Write on one side of the paper only and draw sketches on separate sheets.

REDUCING THE UPSET ENDS OF ROLLER HOUSING SCREWS

We wanted to use, for another purpose, a pair of old roller housings that had seen years of hard service, and in which the adjusting screws had become rusted and upset on the ends. It was impossible to remove the screws without first reducing the enlarged ends, so that they would pass through the threaded holes in the housings. This was accomplished in the following manner:



A device was used, as shown in the accompanying illustration, consisting of a screw jack *A*, one 8-inch square hardwood block *B*, two cast-iron plates *C*, turning tool *D* and adjusting wedge *E*. The cast-iron plates *C* can be made either from a special pattern having the bolt slots cast in them or from stock pieces on hand in the shop. The iron wedge *E* is used for feeding and locking the tool and preventing it from chattering, while the two plates *C* are separated by a block *F*, the same width as the turning tool.

The tool *D* is set as shown in the illustration, and the adjusting screw is rotated by means of the regular wrench. In this way the enlarged end is reduced so that it will pass through the housing. The adjusting screws are 6½ inches in diameter with 4 threads per inch, thus requiring a rigid toolholder.

J. H. M.

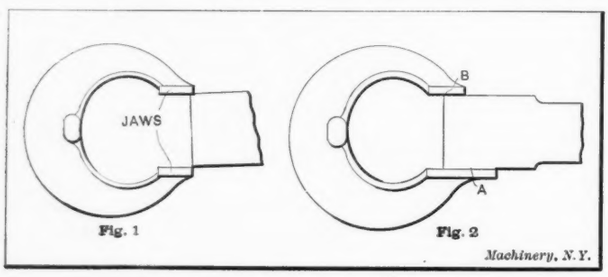
FITTING A PULLEY QUICKLY BY FILING

To file a pulley quickly and have it run true when the hole is only a few thousandths small and when the pulley is held in place by a feather and set-screws, file only the upper half of the hole, *i. e.*, the half in which the keyway is cut. This does not require care, as removing 0.010 inch too much will not affect the truth of the pulley when tightened up.

Erie, Pa. A. N. HAMMOND

IMPROVED CALIPER GAGE

Every machinist and toolmaker has undoubtedly experienced some trouble in gaging parallel surfaces with a caliper gage, especially at the moment when the work is about to enter the jaws of the gage. If the gage is held so that the jaws are slightly inclined to the surfaces to be gaged, the piece will not enter the gage even if it should be several thousandths of an inch under size. This condition is indicated in Fig. 1.



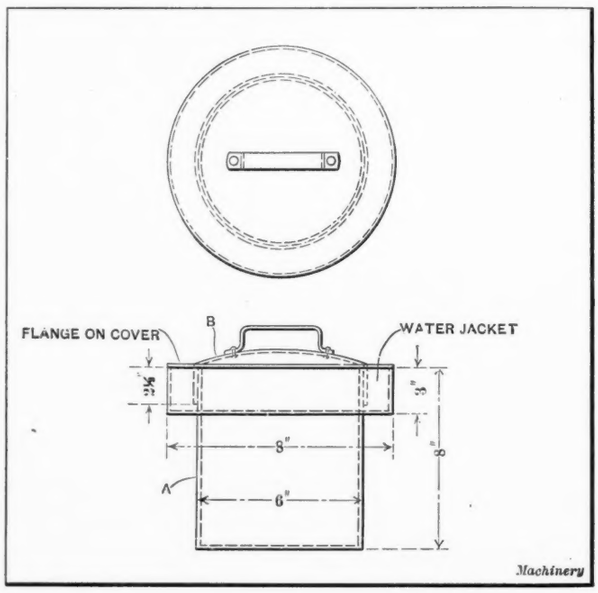
In Fig. 2 is shown a caliper gage which eliminates this difficulty and allows the gaging to be done quickly and accurately. When this gage is used, the long jaw *A* is held against one of the sides of the piece to be gaged and moved along it until the piece enters completely between the jaws, provided it is of the correct size or under size. If the piece is above the correct size it will be brought to a stop against the gage as soon as the short jaw *B* is reached.

BENJAMIN BROWNSTEIN

A GASOLINE CAN FOR THE SHOP

Gasoline in the machine shop is almost an absolute necessity for washing the oil and chips out of taps, dies and similar tools. In many factories, however, its use is prohibited not only because of the danger of fire, but also on account of the cost of the gasoline, which in a large factory amounts to a considerable sum in the course of a year. It is a well-known fact that 80 per cent of the gasoline that goes into the shop is lost by evaporation, it being allowed to stand around in buckets of various descriptions, some even without covers. It was to overcome this loss and afford better fire protection and incidentally to reduce fire insurance premiums, that the gasoline can shown in the accompanying illustration was made.

The body *A* is of the ordinary type, about 6 inches in diameter by 8 inches high, with straight sides. A water jacket is fastened to the outside of the body extending down about 3 inches from the top, and is made 2 inches larger in diameter than the body. The cover *B* is made to fit the body freely, and has a flange extending around the top edge to prevent dirt from getting into the water jacket, which is filled with water. This cover, when in position, forms a water seal through which no gas can escape.



To overcome the abuse to which such articles are subjected in the shop, each can was numbered and charged to the individual using it, according to the system in vogue. Once a week a boy empties, cleans, and refills the cans, and strains the dirty gasoline, and by so doing each man who requires gasoline always has a sufficient supply on hand, without leaving his work to procure it.

Lansing, Mich. E. H. PRATT

GAGING DIES

One shop in which I worked had a ring gage bearing the following inscription: "2¼-inch dies must go through this gage." I saw a man testing a lot of dies with it one day, and those that were a little large he drove through with a hammer. The gage said they *must* go through, so I suppose he was only following directions.

Mansfield, Mass. LESTER P. BROWN

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

HAMILTON RELIEVING LATHE

The lathe shown in Fig. 1 has a relieving mechanism, which is built into and forms an integral part of the design, thus adapting the machine for all kinds of relieving operations, in addition to regular lathe work. Straight or taper taps and reamers and also straight or angular face mills up to 10 inches in diameter and with any number of teeth from two to sixteen, can be relieved. The lathe is not confined to outside relieving, but will also do inside work such as hollow mills, etc.

The relieving mechanism is driven from the back-gearing through change gears and a splined rod *A*, Fig. 2, which extends the full length of the bed, so that the lathe will handle work up to its maximum capacity between the centers. This shaft drives, through an intermediate gear, spur gear *B*, adjustably mounted on a slotted disk keyed to a bevel gear shaft; the latter drives cross-shaft *C*, which, in turn, operates cam *D*. This cam actuates the tool slide by imparting movement to cam link *E*, which bears against an adjustable block *F*. By means of this adjustable block, the throw is varied to suit the work, the position of the block being changed by turning screw *G*, which extends outside of the swivel. Any amount of relief from 1/32 to 5/16 inch can be obtained. Cam *D* is held against the link by a heavy spiral spring, the tension of which can be adjusted by turning a screw-driver screw. This spring insures positive action and eliminates looseness due to wear.

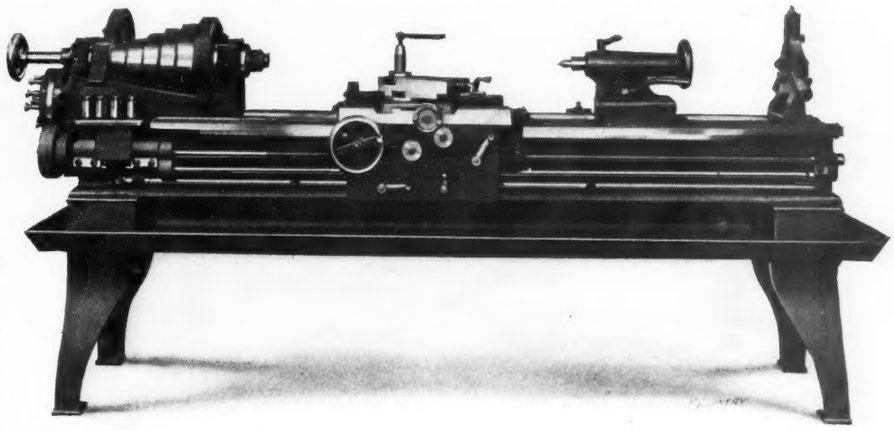


Fig. 1. Hamilton Lathe having Relieving Device incorporated in Design

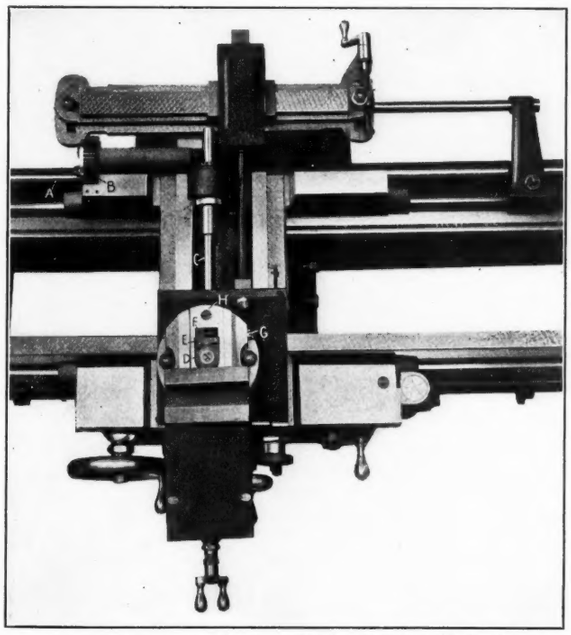


Fig. 2. Plan View of Carriage showing Relieving Mechanism

Gear *B* can be adjusted radially in order to set the work in such relation with the tool that the latter will "kick back" at the proper time. This adjustment is made by loosening two bolts, and it is a convenient feature, as the spindle can be turned by hand for adjusting the work, without changing the position of the cam. Three cams are furnished with each machine, one being double, one triple and one quadruple. These are sufficient for relieving sixteen numbers of teeth, varying from 2 to 16 inclusive. The cam is held in place by a screw and washer and can easily be changed by using a common screw-driver. When the lathe is not to be used for relieving, the short screw *H* should be removed and replaced by a longer screw which is supplied. This simple change converts the machine into a standard lathe.

This relieving device is a development of the Hamilton Machine Tool Co., Hamilton, O. The regular 14- and 16-inch lathes built by this company are the only sizes being equipped with the relieving mechanism at present. These machines are furnished with or without taper attachments, and they are substantially constructed throughout. All shafts in the carriage run in hardened and ground bearings and are provided wih hardened and ground thrust washers. Both the cross-feed and compound-rest screws have double nuts for taking up wear, and the compound-rest base and swivel are equipped with taper gibs. A drawback collet attachment is furnished to take round stock up to 1 inch in diameter. The other features of this lathe are identical with the standard Hamilton 14-inch cone-head pattern.

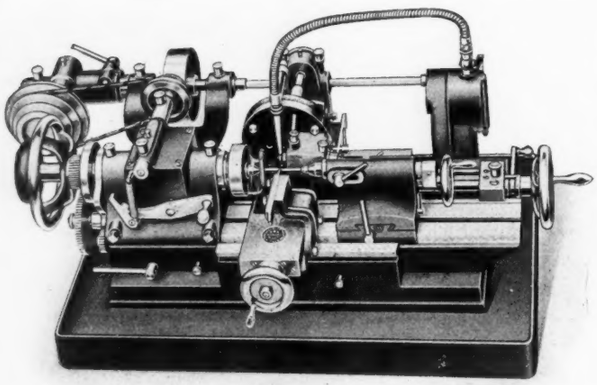
WALTHAM THREAD MILLING MACHINE

A thread milling machine for small precision work, made by the Waltham Machine Works, Waltham, Mass., was described in the department of New Machinery and Tools, December, 1910. An improved design of this machine is shown herewith. It is driven from a constant-speed shaft mounted in brackets attached to the rear of the machine. This shaft is connected, through worm-gearing, with another shaft mounted at right angles in a support or bracket at the left. This intermediate shaft connects by means of four-step cone-pulleys, with a worm shaft which drives a worm-wheel on the main spindle. These cone-pulleys are interchangeable and a total of sixteen speeds can be obtained by shifting the pulleys and belt. The support for the intermediate driving shaft can be adjusted longitudinally to facilitate shifting the belt or to secure the proper tension.

The right end of the constant-speed shaft is connected to a pump that supplies oil to the work-spindle through the flexible hose shown. This pump operates with the shaft running in either direction. The machine is mounted on a pan base of sufficient depth at the rear right-hand corner to hold a supply of oil. The oil, after it leaves the cutter, falls into a receptacle on the cross-slide from which a channel leads to the rear of the machine close to the oil reservoir. The pan base is inclined so as to return all surplus oil to the reservoir.

A clutch that is automatically released when the machine has reached the completion of the cut, is placed on the new

machine directly on the work-spindle, and a large handwheel is provided on this spindle so that the carriage can be returned to the starting point by hand without disengaging the gearing. The gearing, however, can be disengaged, if desired, and the carriage returned by the handwheel on the right end of the lead-screw. The centers have been raised in the new model so that work three inches in diameter can be handled if the pitch of the thread is not too coarse. The bed has also been extended so that longer work can be held on centers, and the travel of the carriage is increased from 6 inches to 7¼ inches. Another size of this machine, which is 6 inches longer than the one illustrated, is also made. The



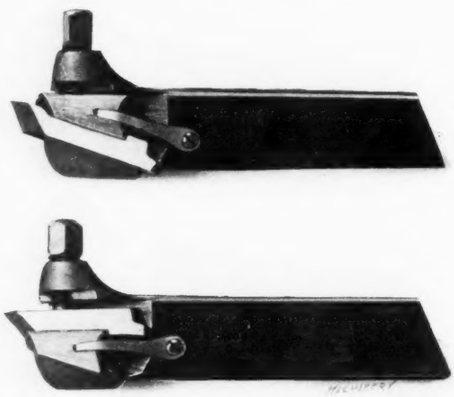
Precision Thread Milling Machine, built by Waltham Machine Works

tailstock has a cross-slide so that tapers too slight to be obtained by the taper attachment, can be cut, or the alignment of the centers can be rectified, if necessary.

The compensating bar for varying the lead of the screw, is altered so that sufficient variation can be obtained to allow for shrinkage in hardening, etc. A pointer attached to the swiveling bar, reaches through to a graduated index on the front of the machine and shows the amount of increased lead that can be obtained. The bar can be swiveled by moving two thumb-screws at the front of the machine. The right-hand bearing of the lead-screw is threaded and this bearing can be rotated by a lever to change the location of the carriage in relation to the cut, thus making a fine adjustment for locating the cutter to work previously milled.

KRIEGER ADJUSTABLE TOOL-HOLDER

The Krieger Tool & Mfg. Co., 564-572 W. Randolph St., Chicago, Ill., has added to its line of tool-holders a type which permits the position of the cutter, in relation to the work,



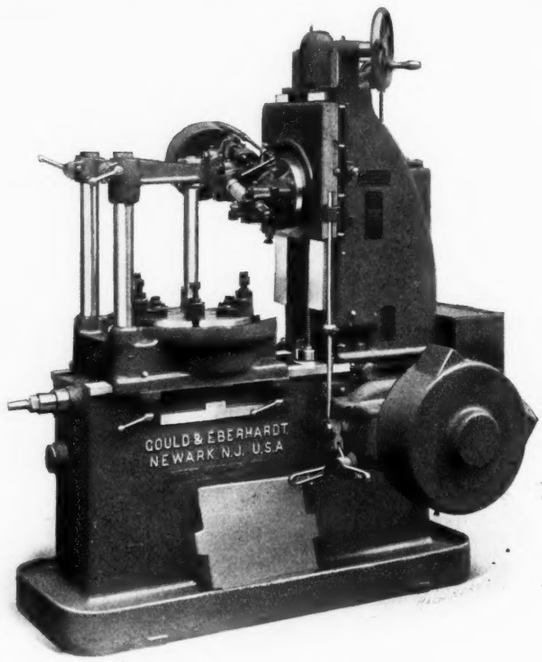
Tool-holder arranged so that Cutter can be set in an Angular or Level Position

to be changed as required. The upper view in the accompanying illustration, shows the cutter in an angular or inclined position for turning iron and steel, and the lower view shows it set level for turning brass. As the illustration plainly indicates, these changes are effected by a tapered block, which, in one case, is placed above the tool and, in the other, beneath it. When the cutting tool is clamped in the holder in an inclined position, it is tilted sidewise, thus giving the top of the cutter side slope for turning iron or steel, and when it is set horizontally, as shown in the lower view, the top is level and in the proper position for thread cutting or turning brass, etc. The cutter is held firmly on all sides, regardless of its position.

GOULD & EBERHARDT AUTOMATIC HOBBING MACHINE

Among the latest improvements embodied in the high-duty hobbing machines manufactured by Gould & Eberhardt, Newark, N. J., there is a single-pulley drive instead of the cone drive, ten changes of speed obtainable through gearing, and an automatic stop which disengages the entire mechanism of the machine when it has completed cutting a spur or helical gear.

The single driving pulley rotates at a constant speed and delivers the maximum power continuously. Previously it was necessary to reduce the speed of the cone-pulley when using hobs of large diameter, because the large hobs could not be run as fast as the smaller sizes. This reduction of the cone-pulley speed also decreased the driving power when it was most needed; that is, when using large hobs. The single-



Gould & Eberhardt High-duty Automatic Hobbing Machine for Spur and Helical Gears and Worm-wheels

pulley drive, in conjunction with the speed-changing mechanism, also makes it unnecessary for the operator to shift the driving belt, which is always more or less dangerous.

As previously stated, there are ten changes of speed obtained by means of change gears, as against four changes with the cone-driven type. This range enables the operator to regulate the speed in accordance with the diameter of the hob or the quality of the metal being cut. When using small hobs, the speed of the machine can be increased, thus increasing the output without increasing the cut per tooth, as the feed per revolution of the blank remains constant. The speed is also governed by the kind of steel used in making the hobs.

The automatic stop mechanism enables the operator to set the cutter-slide trip-dog so that when the gear is finished, the entire mechanism of the machine will be stopped automatically with the exception of the driving pulley. This feature is especially valuable when cutting helical gears, as, heretofore, the operator has had to stop the machine by

shifting the countershaft belt. This had to be watched closely to prevent the cutter slide from feeding down and jamming against the revolving table, but if the feed were disengaged before the hob had entirely cleared the gear, the hob would mill the teeth away, thus spoiling the work. With the present arrangement, if the feed is accidentally or otherwise disengaged before the gear is finished, the entire mechanism of the machine will be stopped and no damage done. This automatic arrangement makes the machine positively "fool-proof" at this point. It also enables the operator to feed up to a shoulder or line when cutting a helical or spur gear, and, as the cut is automatically stopped at the same point on every blank, there is the added advantage of making the work uniform. One man can also operate more machines having automatic stops, than is possible with the previous type.

A neat form of belt guard has been placed over the driving pulley, as shown. This guard can be adjusted to suit the angle of the belt and, if desired, it can be entirely removed without difficulty. All running gears of the machine are also enclosed with guards for the protection of the operator.

CINCINNATI SLOW-SPEED PLANER DRIVE

The planer illustrated in Figs. 1 and 2 is equipped with an electric variable-speed drive, having an additional slow speed arrangement for use when machining extremely hard castings, such as chilled rolls, etc. These slow speeds are also very useful when planing work of irregular shape or wide surfaces which are finished by a form tool requiring a comparatively slow speed.

The planer, which in this case is a 36-inch size, is driven by a 2 to 1 variable-speed motor, coupled directly to the top shaft. This shaft runs in ring-oiled bronze-bushed bearings and has keyed to it the regular "cut" and return pulleys *A* and *B*, Fig. 2. Any predetermined speed for the cutting and return strokes is obtained by adjusting the handles *C* and *D*, Fig. 1, on the controller. The drive, as far as described, constitutes the regular arrangement and gives cut-

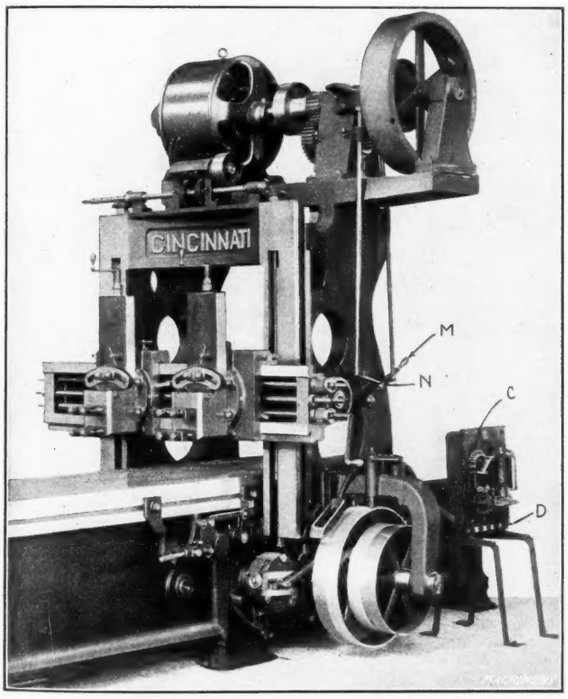


Fig. 1. Cincinnati Planer having Slow-speed Drive which can be engaged when necessary

ting speeds ranging from 27 to 54 feet per minute and return speeds from 75 to 150 feet per minute. Any combination of these speeds can also be obtained. For example, the cutting stroke can be given a speed of 27 feet and the return a speed of 150 feet, or the cut can be increased to 40 feet and the return reduced to 100 feet per minute. Instead of varying both speeds, the return speed, for example, can be set to 100 feet and the cutting stroke can be varied as desired. These changes can be made instantly with the machine idle or operating on either stroke.

The special slow speeds are obtained through back-gears. Referring to Fig. 2, pinion *E* is keyed fast to the top shaft and engages with gear *F*, which is keyed to the back-gear shaft carrying pinion *G*. The latter meshes with gear *H* which is keyed to the hub of pulley *J*, mounted loosely on the top shaft. By moving handle *N*, the driving belt is moved from pulley *A* to *J*, giving a slow speed to the planer driving

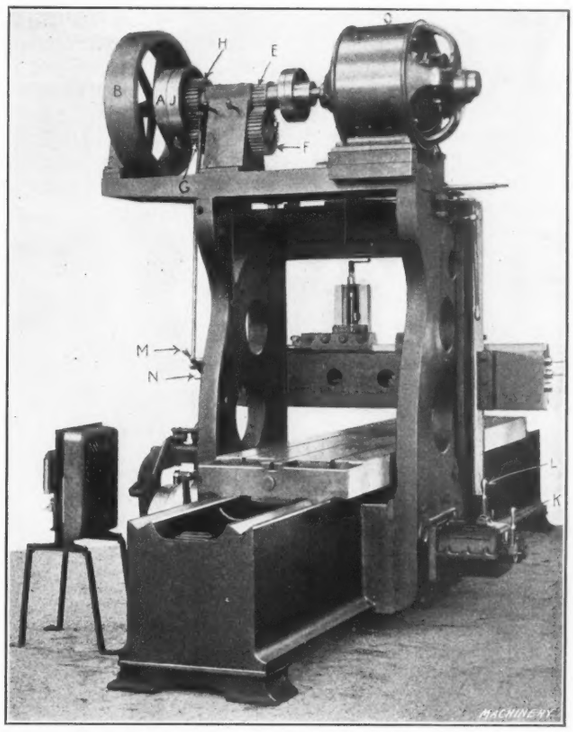


Fig. 2. Rear View of Planer having Slow-speed Drive

pulley. A further speed reduction can then be made through back-gears on the left side. To change the planer from the slow to the regular speeds, it is simply necessary to disengage the back-gears by operating handle *K*, change the position of the reverse clutch handle *L* and shift the "cutting" belt from pulley *J* to *A*, handle *N* being provided for this purpose. If the planer is to be used on regular speeds for any length of time, the back-gears *F* and *G* can be disengaged by operating handle *M*.

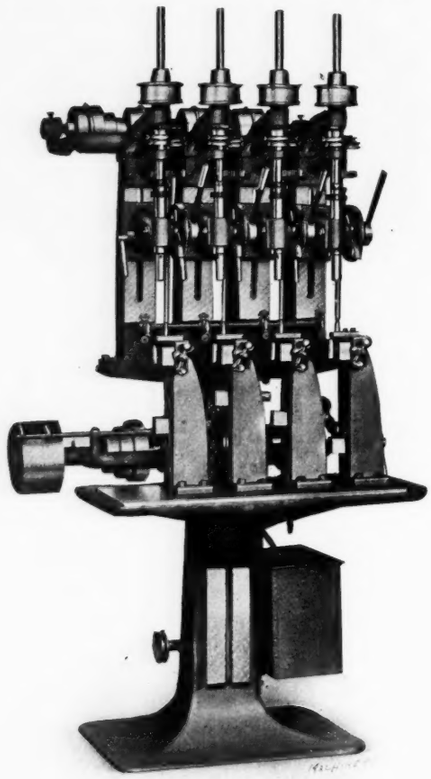
This makes a very flexible arrangement, as cutting speeds can be obtained, ranging from 1.6 feet to 3.2 feet with the back-gears, and from 27 to 54 feet per minute when driving in the regular way. This planer is built by the Cincinnati Planer Co., 3150-3152 Superior Ave., Cincinnati, O.

FOOTE-BURT FOUR-SPINDLE STAYBOLT DRILL

The staybolts which are used as supports between the inner and outer sheets of boilers often break entirely off or are cracked, doubtless because of the unequal expansion of the sheets and the resulting bending strains to which the bolts are subjected. One well-known method of detecting broken staybolts is by sounding them with a hammer, preferably when the boiler is under a slight hydrostatic pressure. When a bolt that is entirely broken is struck with a hammer, it gives a sound that is quite different from one that is solid, and in this way, bolts which are broken completely off can be detected with considerable certainty, by an experienced man. When there is only a partial fracture, however, the defective bolts are not found so easily and the hammer method is rather unsatisfactory. To do away with all uncertainty, locomotive boilers have been equipped for some years with bolts having small holes drilled centrally in the ends to a depth somewhat greater than the thickness of the sheet. When such a bolt becomes broken or is fractured as far as

the central hole, water will be blown out through this hole and the defective bolt is discovered immediately.

The Foote-Burt Co., Cleveland, O., has designed a machine (which is illustrated herewith), especially for drilling these telltale holes in staybolts. This drill has four spindles with a power feed and sensitive drive, which, in connection with special chucks for quickly gripping and centering the bolts under the spindles, gives a very rapid production. Each spindle has three independent speed changes and two variations of power feed, as well as an automatic trip which disengages the feed when the hole has been drilled to the desired depth. By having an independent feed for each spindle, one operator can readily run all four spindles, thus obtaining a much larger output than would be possible with a single-spindle machine. The speed or feed of any spindle, can be instantly changed without affecting the other spindles. The drills run in bushings which insure starting them central with the work, and the chucks are accurately aligned central with each spindle. An oil pump with piping and a return tank, is provided so that oil and soda water can be supplied to the



Foote-Burt Four-spindle Machine for Drilling Telltale Holes in Staybolts

drills. This machine will drill to a depth of 3 inches, and has a capacity for drills up to 5/16 inch in diameter. Staybolts ranging from ¾ to 1¼ inch in diameter and with lengths varying from 3 to 15 inches, can be held in the chucks. The chucks and their supporting fixtures can be quickly removed from the table, so that the machine can be used for a variety of sensitive drill work.

The distance from the spindle centers to the face of the column is 7½ inches and the spindles are 6½ inches apart. The maximum distance between the nose of each spindle and the top of the table is 36 inches, and the minimum distance, 4 inches. In addition to the power feed, the spindles can be fed by hand, and there is a quick return movement. The table is counterbalanced by a weight inside of the column. The weight of the machine is 1200 pounds.

LANGELIER SPECIAL SAWING AND DRILLING MACHINE

The accompanying views, Figs. 1 and 2, illustrate a machine built by the Langelier Mfg. Co., Providence, R. I., for sawing to length and drilling the two cross holes, simultaneously, in the Dobby chain lags that are used on weaving looms. The construction consists principally of a frame carrying a cross arm or rail on which the two saw crossheads are mounted. These crossheads are connected to a right- and left-hand screw in the cross arm, and, by means of this screw, the saw heads can be adjusted either in or out for lags of different length. This adjustment enables lags varying in length from 3½ inches to 11½ inches to be machined.

The drill heads are fastened to the saw crossheads, and they can be adjusted independently by means of "pull-and-

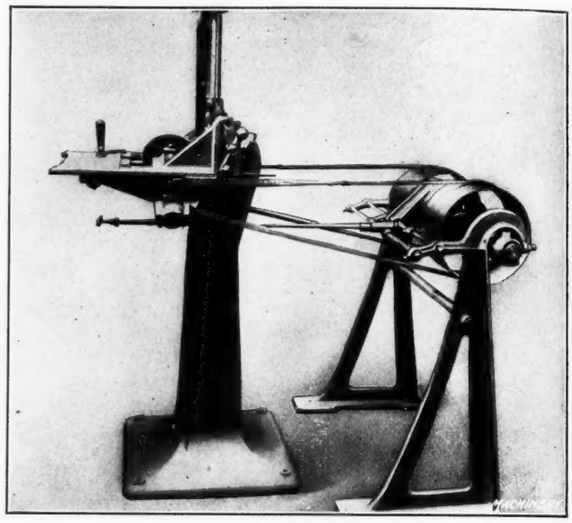


Fig. 1. Side View of Langelier Sawing and Drilling Machine for Dobby Chain Lags

push" screws. Each crosshead and the saw shaft bearing is cast integral with the table track. The table is of the push type and is constructed in three parts, there being an intermediate part for each of the different lengths of lags. On the inner end of this intermediate section there is a trough conforming to the shape of the lag, for accurately locating and holding it for the machining operations. The angular sides of this trough also act as a jig for drilling the two cross holes. Stops are provided for limiting the travel of the table in both directions, and there are means for automatically returning the table. On the narrow intermediate part, a spe-

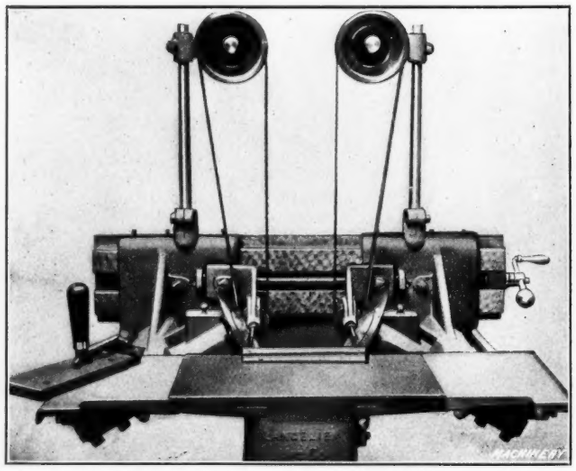


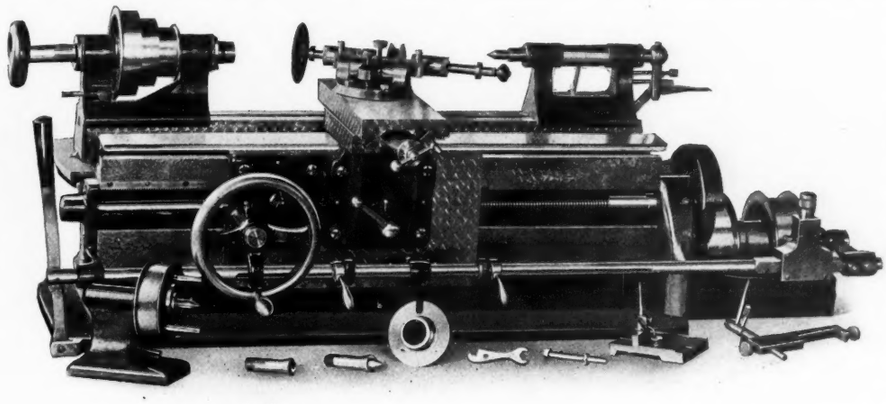
Fig. 2. Front View of Langelier Machine

cial holding clamp is provided to prevent possible injury to the operator's hands when machining lags that are comparatively short. One of these clamps is shown in Fig. 2 on the left end of the table. The drilling spindles are driven by pulleys, as shown, which are connected by belt to an overhead countershaft, and the saws are driven by belts connecting with a floor countershaft at the rear of the machine, as shown in Fig. 1. The saw shafts are multi-shouldered and have babbitt metal cap bearings. These saws are 6¾ inches in diameter.

HARDINGE UNIVERSAL GRINDER

A recent addition to the line of precision tools manufactured by Hardinge Brcs., 3133 to 3141 Lincoln Ave., Chicago, Ill., is shown in the accompanying engraving. This new product is a universal grinder designed to do all kinds of internal and external grinding, on work up to 7 inches in diameter and 18 inches long, and it is especially applicable to the grinding of cutters, reamers, end-mills, saws, and other tool-room work of a varied nature, requiring a high degree of accuracy.

The base of this machine has mounted on it a swiveling bed which enables the grinding of tapers, and as this table is designed to carry the Hardinge dust-proof bench-lathe heads, the latter can be used interchangeably. This application of



Hardinge Universal Grinder

bench-lathe heads to the grinder is an important feature as it makes possible the use of various attachments which greatly increase the range of the machine. Any lathe head varying from the No. 3 size, having a capacity of ½ inch through the draw-back collet, to the No. 7 size, inclusive, with a capacity of 1⅝ inch through the collet, can be applied to the grinder. It should be mentioned in passing that the spindles and journals of these lathe heads are protected from emery or other abrasive material by felt rings and dust caps, which seal the bearings. The angular position of the bed is shown by a steel plate inserted in the base on the left side. This plate is graduated to 10 degrees on each side of a central zero line, and as the graduations are on a circle 36 inches in diameter, accurate readings can be taken. This means of obtaining accurate angular adjustment is desirable in order that fine tools, such as reamers or cutters, having a slight taper or angle, can be ground accurately to the angle required. The angular position of the bed is changed by unlocking two hand nuts, which are easily reached by the operator when in front of the machine.

The wheel spindle is mounted on a slide which is not directly operated by the cross-feed screw, but is carried by a lower slide, as the illustration shows. The upper slide is secured to the lower one by knurled screws at the side; by simply loosening these screws, the operator can move the grinding wheel rapidly to and from the work. When a fine adjustment is desired, the lower slide is moved by the handle in front, which is provided with an accurate micrometer dial. The base carrying the grinding spindle can be set to any angle, as it is graduated to 360 degrees. These graduations are on a beveled edge, so that they can be read easily and accurately. The traverse spindle is hardened and ground and runs in adjustable journals, which are protected with felt rings similar to those in the bench-lathe heads, and special oiling facilities are provided to insure good lubrication. In each end of the spindle there is a standard taper hole, so that the wheel can be placed on either end as required.

The carriage, containing the compound slide and grinder head, is mounted on the front of the base, and the top bearing surface is carefully protected from grit by a shield which is plainly shown in the illustration. This carriage has an automatic feed in either direction, the reverse movement being obtained by shifting the vertical lever seen at the extreme left. This lever is connected by a shaft with a clutch located between the feed pulleys which are driven by open and cross belts. Feed-control stops are provided for automatically disengaging the feed at any predetermined point. These feed-stops are located on the reverse shaft, and are provided with knurled nuts giving a micrometer adjustment. The power feed is engaged by a lever at the center of the carriage, which operates a split nut, and the wheel to the left is used for hand operation.

Some of the attachments used on this grinder are also shown in the illustration. To the left, a "dead-center" head for external work or quills is shown, and to the extreme right, there are two forms of stop fingers for cutter grinding. One of these stops is designed for straight face cutters and the other for cutters having spiral teeth. This equipment, in connection with the bench-lathe heads, which enable the use of draw-back chucks, wheel chucks and closers, and independent and universal chucks, adapts this machine to a wide range of work. The countershaft provided with the grinder is arranged to give variations of speed and is so constructed that the work or grinding wheel can be stopped independently of the main drive.

ROCKFORD HORIZONTAL DRILLING, BORING AND FACING MACHINE

A horizontal drilling, boring and facing machine, built by the Rockford Drilling Machine Co., Rockford, Ill., is shown in Fig. 1. This latest design is equipped with a direct motor drive, the motor being mounted on an extension of the ma-

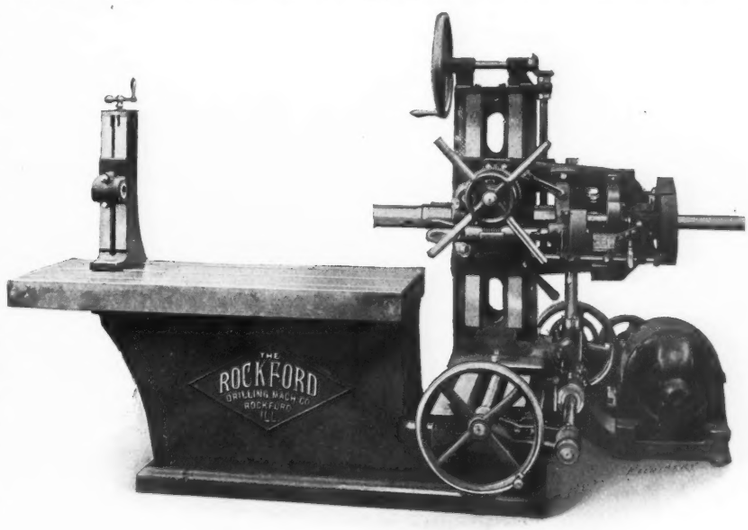


Fig. 1. Rockford No. 2 Motor-driven Horizontal Boring and Facing Machine

chine base, thus forming a complete unit. An important advantage incident to this construction is that the machine can be conveniently picked up by a crane and carried to any part of the shop where it might be required.

The motor is of the direct-current variable-speed type and

it drives through gearing, as shown in the rear view, Fig. 2. On the main horizontal driving shaft there are two sliding gears, either of which can be engaged with intermediate gears that connect with the driving pinion of the motor. By means of this back-gearing, a ratio of 5 to 1 is obtained.

The machine has, in addition to the positive geared drive, a positive geared feed, giving variations ranging from 0.005 to 0.060 inch per revolution of the spindle. The amount of feed for any position of change gears is shown by a pointer and index plate, and the changes are made by handles conveniently located on the saddle. There is also an automatic trip for disengaging the feed, which operates at any point within

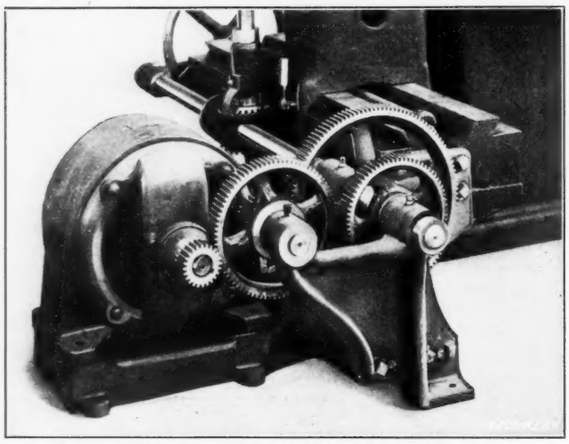


Fig. 2. Rear View showing the Motor Drive and Back-gears

the full travel of the spindle sleeve without the use of trip dogs on the sleeve. A detailed description of this feeding mechanism was published in July, 1911, in connection with a description of a belt-driven machine of the same type. The spindle has a vertical travel on the column or vertical head, of 18 inches, and the column has a maximum lateral movement of either 12, 24, or 36 inches, the distance being varied to suit individual requirements.

AUTOMATIC CONTROLLERS FOR MOTOR-DRIVEN MACHINERY

The Electric Controller & Mfg. Co., of Cleveland, O., has recently brought out a line of automatic controllers, designed especially to give the utmost convenience in the control of motor-driven machinery. The advantage of convenient control and its effect on production is universally recognized, and these controllers were designed to provide such a control

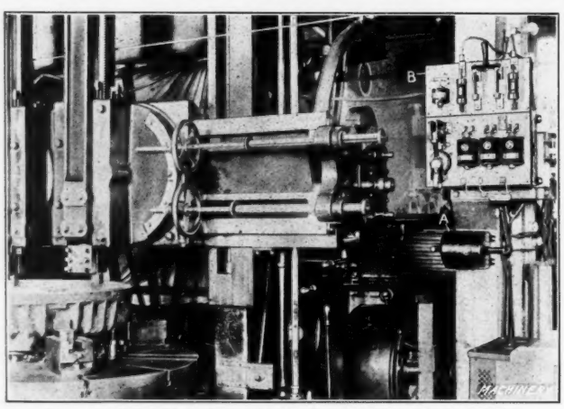


Fig. 1. Electric Controller & Mfg. Co.'s Automatic Controller applied to Boring Mill

for starting, stopping or reversing motor-driven machine tools or other electrically driven machines.

The controller consists of a small operator's switch and an accelerating unit, and it is built in three types to secure, first, non-reversing and dynamic braking; second, reversing without dynamic braking; and third, reversing and dynamic braking. In each type, four different forms of accelerating units are available, which vary in their design from a simple train of accelerating switches up to a unit having a fused service switch, a train of accelerating switches, and complete circuit breaking features. The accelerating unit automatically accelerates or retards the motor through the action of series-wound accelerating switches, which act not only as switches but as current limit relays as well. When the current in the winding of one of these switches exceeds a predetermined value, the switch locks open and cannot close until the current is reduced to the proper value.

Fig. 1 shows one of these automatic controllers installed in connection with a large boring mill. The operator's switch is located at *A* and the accelerating unit at *B*. The method of mounting one of these operator's switches on a shaper is shown in Fig. 2. When the operator's switch is thrown to the running position, current flows through the motor, all of the starting resistance, and the coil of the first series-wound accelerating switch. As the motor accelerates, the current drops, and when it reaches the correct value, the first accelerating switch closes, cutting out part of the starting resistance. The succeeding accelerating switches operate similarly, ultimately cutting out all of the starting resistance and putting the motor "across the line." By throwing the operators' switch to its original position, the motor is disconnected from the line and, consequently, stops. Different positions of the handle of different types of operator's switches, provide for drifting, reversing, or rapid stopping by dynamic braking.

Dynamic braking is secured by a change of connections, made by the operator's switch. All the starting resistance

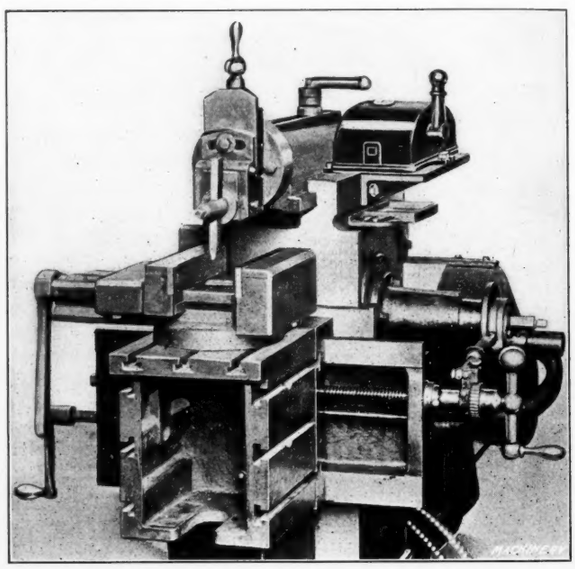


Fig. 2. Operator's Switch mounted on Shaper

is first inserted in series with the armature; the motor is then quickly and evenly brought to rest by automatic dynamic braking, the accelerating switches, in this case, acting as "decelerating" switches by cutting out the resistance step by step, as the current generated by the motor, decreases due to the slowing down of the motor.

The manufacturers claim the following important advantages for this automatic controller: It limits the accelerating and retarding current at all times to a safe value; it accelerates and retards the motor in the minimum safe amount of time, and automatically varies the time of acceleration and retardation, depending upon the load which the motor has to start and stop; it provides the best conditions for good commutation; it limits all mechanical strains on the motor and driven machinery by limiting the current both in starting and stopping; it obviates the necessity of mechanical clutches on many motor-driven machine tools; it adds very materially to the safety of an installation, because, in case of accident, the motor can be stopped quickly; it inherently provides no-voltage protection, for, if the voltage fails, the switches drop open, and upon the return of voltage, they automatically close in their regular order, again accelerating the motor to full speed.

HARDINGE AUTOMATIC LOCKING FOOT-TREADLE

Three styles of an automatic locking foot-treadle, which are intended for all small belt-driven machines requiring a treadle shifter, are shown in Figs. 1 and 2. The belt is shifted to the tight pulley by the downward movement of the treadle, which operates a bellcrank lever that is connected with the countershaft by a wire. After the treadle is pressed down, it is locked by the upward pull of the wire leading to the countershaft, and in order to unlock it for stopping the lathe, it is simply necessary to press down the heel part of the treadle. The lock for the running position enables the operator to remove his foot from the treadle, except when starting or stopping, and the action is as easy as though there were no locking feature.

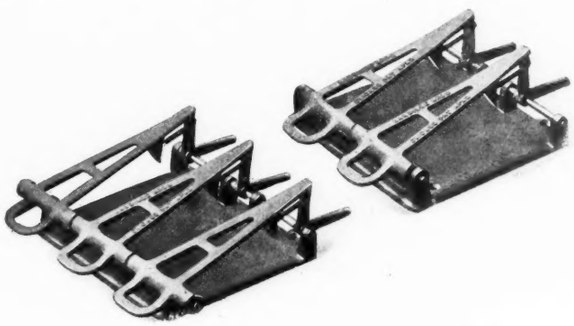


Fig. 1. Hardinge Foot-treadles in Locked Position

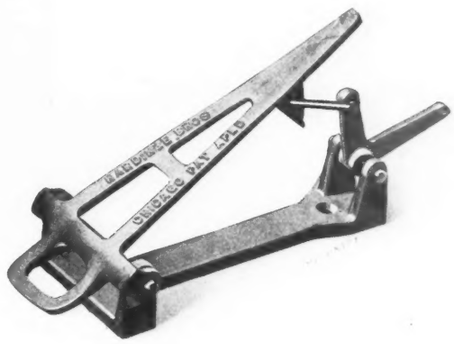


Fig. 2. Treadle in Raised or Unlocked Position

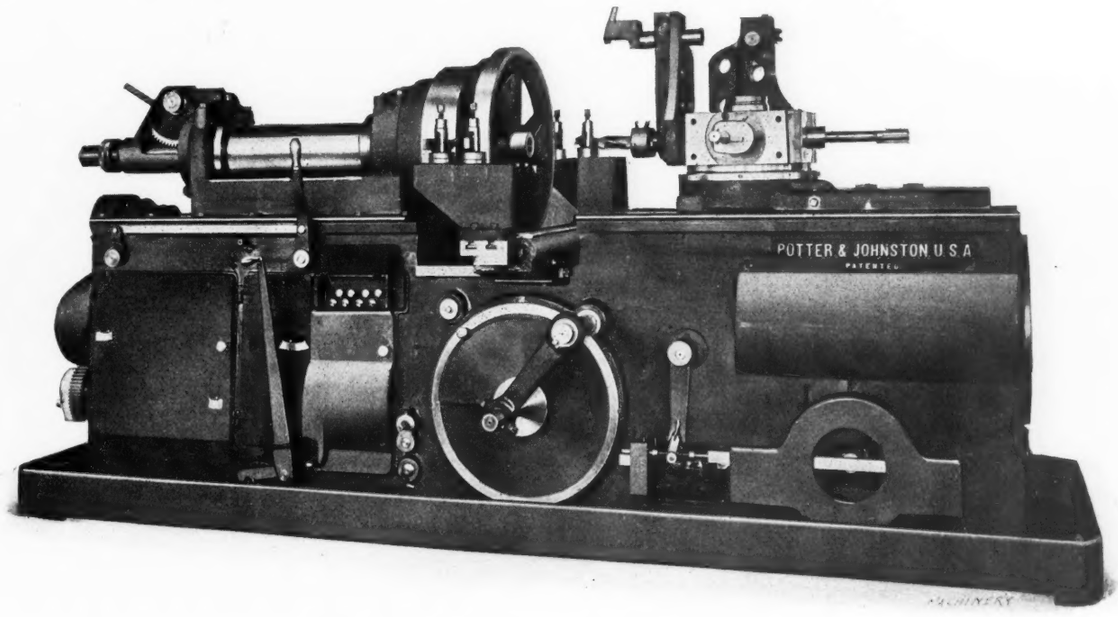
The advantage of this device will be thoroughly appreciated by the users of bench lathes or other machines which are set in motion by means of treadle shifters, because this improved design makes it unnecessary for the operator to stand with one foot on the treadle and sustain his entire weight on the other, as with devices used heretofore. The treadles shown in Fig. 1 are in a downward or locked position, while the single type illustrated in Fig. 2, is unlocked. The general arrangement of this improved treadle and its locking feature is clearly shown in the engravings, so that further description is unnecessary. This treadle is manufactured by Hardinge Bros., 3133 to 3141 Lincoln Ave., Chicago, Ill., for one-, two-, and three-speed countershafts, and it will be furnished regularly with the bench lathes built by this company.

POTTER & JOHNSTON AUTOMATIC CHUCKING AND TURNING MACHINE

The Potter & Johnston Machine Co., Pawtucket, R. I., has brought out a new automatic chucking and turning machine, known as the No. 7-A model. This latest design is of the same general construction as the Nos. 5-A and 6-A models, but it has increased capacity and power and is especially adapted for the manufacture of motor truck parts, such as chain sprockets, brake drums, hubs, pistons, cylinders, flywheels and similar work in this and other lines. The accompanying illustration shows the machine set up for turning the large rear sprockets of motor trucks. As is well known, all the cutting operations are performed automatically by these machines, and one workman can operate from two to six machines, the number depending on the nature of the work.

The headstock of the No. 7-A model can be adjusted along the bed, within certain limits, to suit the length of work being machined. All speed changes are obtained through gearing enclosed in the base, and the spindle has four automatic and five hand speed changes, the latter of which are obtained through change gears, thus giving a total of twenty spindle speeds. These speeds vary in geometrical progression from 5½ to 163 revolutions per minute. The spindle is driven by a gear attached to the chuck or faceplate, thus eliminating torque. The speed clutches are powerful friction clutches, which drive the heaviest work and, at the same time, absorb all shock when changing from one speed to another.

There are four automatic changes of feed, including a



Potter & Johnston No. 7-A Automatic Chucking and Turning Machine

threading and reaming feed, and six hand changes. Any variation of speed within the range of the machine can be obtained through change gears, which are regularly furnished. All the automatic changes of speed and feed are actuated by revolving cams, and as the changes are practically instantaneous, they can be made at any part of the cutting stroke.

The cross-slide is provided with front and rear tool-blocks, each of which carries two toolposts. This slide is adjustable longitudinally along the bed and is of a very strong construction. The turret has four stations upon which tools may be mounted, and with each machine an outfit of turret turning tool-holders, stems and cutters is furnished. The turret is advanced, returned and revolved automatically, and as these movements are performed at a high constant speed, little time is lost in changing from one operation to another. When the turret slide has advanced to the point where the tools begin cutting, a slower feeding motion is automatically engaged. A 21-inch, three-jawed scroll chuck, having a standard set of jaws, is supplied. This chuck is equipped with a pilot bushing to receive pilot bars for supporting the turret tools. An oil pump and piping, with an oiling arrangement through the turret, is also furnished when the material to be machined requires a lubricant. As the machine has a single-pulley drive, the application of a motor is very simple. The bracket for the motor is bolted to the base and the drive is through a pinion and gear which is substituted for the regular driving pulley. A constant-speed motor is recommended. By means of change gears, the variations of speed and feed common to the belt-driven machines are obtained with the motor drive.

The general dimensions of the No. 7-A automatic are as follows: Swing over the bed, 29 inches; swing over the cross-slide, 21 inches; travel of the cross-slide each way, 7 inches; turning limit with a standard turning tool (diameter), 21 inches, and with a special tool, 29 inches; diameter of holes in turret, 2½ inches; depth, 4½ inches; distance from center of turret hole to top of slide, 4⅜ inches; maximum turret slide travel, 21 inches; length of turret slide travel which permits the supporting and piloting of turret boring tools, 10 inches; diameter of spindle bearing, 7¾ inches; maximum diameter which will pass through the spindle, 6 inches.

SAXON SURFACE GRINDER

The J. A. Stowell Co., Leominster, Mass., is now manufacturing an improved design of the Saxon surface grinder, which appears, as far as can be judged from a study of the illustration, to be a very simple and durable machine. There are comparatively few parts in the design and the machine is heavily constructed to absorb all vibrations and facilitate the rapid production of precision work.

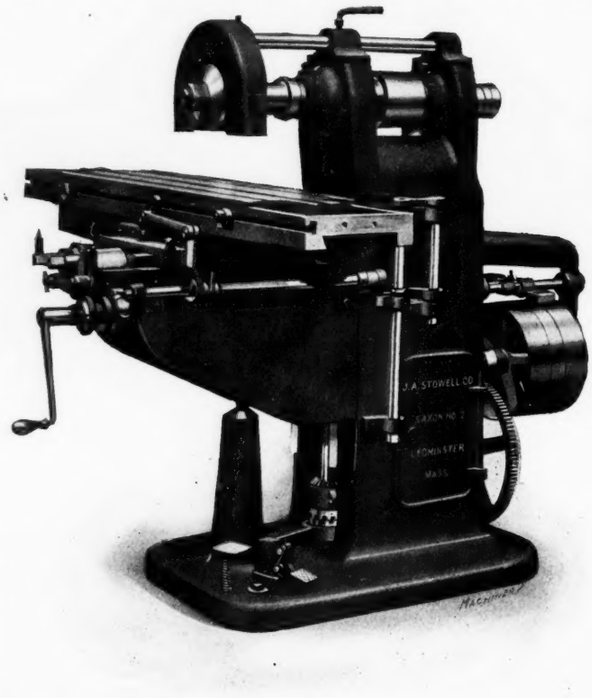
The grinding-wheel spindle is driven from an overhead countershaft which also drives the table reciprocating mechanism by open and cross belts operating on pulleys at the rear of the column. The shaft carrying these pulleys drives, through spur gearing giving a large speed reduction, a lower horizontal shaft which connects through bevel gears with an intermediate vertical shaft shown at the front of the column in the illustration. This vertical shaft, in turn, imparts movement to a horizontal shaft mounted in the knee and carrying a gear which meshes with a rack on the under side of the table.

The stroke of the table is controlled by trip dogs at the front which, through the connections shown, operate a reversing shaft at the side of the knee. This reversing shaft, in turn, connects through a suitable mechanism with belt shifters at the rear. The table can also be reversed at any point by means of the hand lever attached to the front end of the reversing shaft. The starting or stopping of the table is controlled by a foot-treadle, through the medium of a clutch, which engages or disengages the vertical intermediate shaft with the driving bevel gears at its lower end.

The transverse feeding motion for the table is derived from the rack gear shaft in the knee, which drives, through a friction clutch, a shaft having a slotted disk on the outer end, connected by a short rod with a ratchet mechanism, operating a feed-screw shaft at the left. The slotted disk gives the necessary feed variations, and the automatic feed occurs at each end of the stroke. The direction of the feeding movement can be reversed by simply turning the feed pawl. The table can be shifted longitudinally, transversely, or vertically by the crank handle shown, which fits the three adjusting shafts. The vertical adjustment is shown by a dial graduated to thousandths of an inch.

The bearing surfaces of this machine are large and are protected by dust guards. The guards at the ends of the table and above the front of the knee were detached from the particular machine illustrated in order to give a better view of the mechanism. The spindle is of crucible steel, accurately turned and ground, and runs in bearings of ample dimensions. The bearings are provided with fiber thrust collars and adjustment for eliminating lost motion, and they are self-oiling as well as dustproof. All handles and levers for controlling the various motions are operated from the front or working position. A water attachment is furnished with this grinder when desired. This attachment, however, reduces the working capacity 1½ inch in width and the same amount in height.

This grinder is built in two sizes known as Nos. 2 and 3. The smaller size has a capacity for work 36 inches long, 10½ inches wide and 12 inches high, and the larger size, for work 45 inches long, 12 inches wide and 10 inches high. Each size takes a 12- by 1½-inch wheel. The diameters of the respective spindles are 2 and 2¼ inches; and the maximum distance from the top of each table to the spindle center, 18 inches and 16 inches. The rate of the table travel is 16 feet per minute for both sizes. The dimensions of the bearings are 8½ and 7 by 2 inches, and 10 and 9 by 2¼ inches, and the complete weights, 1900 and 3000 pounds, respectively.

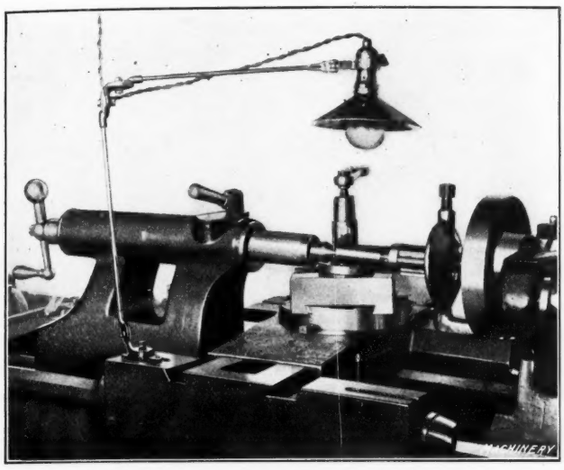


Surface Grinder built by the J. A. Stowell Co.

ADJUSTABLE LAMP BRACKET

The lamp bracket shown attached to the rear of a lathe carriage in the accompanying view has a universal adjustment which enables the light to be directed where it is most needed. The importance of this feature will be appreciated particularly by all machine tool operators. This same bracket can also be attached to the wall and is applicable not only to machine shops, but to drafting-rooms, etc. The bracket is equipped with universal joints formed by disks and so arranged as to give both horizontal and vertical movements. Between each pair of disks there is a friction washer, and the amount of friction can be regulated by screws and lock-nuts which keep the friction uniform at any desired tension. The

arms are of solid steel and the disks are of malleable iron and machined to form a good bearing for the friction washers. The lamp itself can be quickly removed from the bracket when desirable, as it is held in place by a spring clamp. These brackets are plated by an electro-galvanizing process giving an aluminum finish which is rustproof and pleasing to the eye. The bracket is made in several different styles so that it can



Adjustable Lamp Bracket for Shops or Drafting-rooms

be attached to the ceiling, floor, bench, etc., and all of these, except the one intended for bench or desk use, are 30 inches long, thus giving a total range of 5 feet. This bracket is manufactured by the McCrosky Reamer Co., Meadville, Pa.

RELIEVING ATTACHMENT FOR SENECA FALLS LATHES

The Seneca Falls Mfg. Co., 330 Water St., Seneca Falls, N. Y., has brought out a new relieving or backing-off attachment for use on the 14- and 16-inch, quick-change, tool-room lathes built by this company. The tool-slide is attached to the cross-slide of the carriage, in place of the compound rest, and it will operate at any angle through an arc of 180 degrees or 90 degrees each way from the center of the carriage. The lower part swivels on the cross-slide the same as a compound rest, and the upper part, containing a pair of driving bevel gears, swivels on the lower part to permit the free working of the driving shaft which is connected to the driving mechanism by universal joints. The stroke can be adjusted while the machine is in motion, to give any amount of relief from 0 to ¼ inch, the amount being indicated by graduations on the adjusting knob.

The driving mechanism is attached to the bed in front of the headstock, and receives power from the large spindle gear. The number of strokes per revolution of the work is governed by change gears. A set of gears is furnished giving twenty-two variations, including all numbers from two to sixteen, and even numbers from eighteen to thirty.

The attachment may be so easily and quickly disconnected, that it does not interfere with the regular operation of the lathe. The tool-slide is removed by loosening a binding screw (a patented device that is much quicker and easier to operate than the regular T-bolts), pulling out a splined shaft from the driving mechanism, and then throwing the driving gear out of mesh with the headstock gear.

This attachment can be used in connection with the taper attachment and micrometer cross-feed stop, and also with the power cross and longitudinal feeds. Special cams can be used for turning elliptical and other irregular shapes.

BRISTOL RECORDING INSTRUMENT

The semi-transparent smoked chart recorder made by the Bristol Co., of Waterbury, Conn., is an instrument that is fundamentally simple in its construction and extensively used, but there has been a demand for a recorder in which the record is made with ink. To meet this demand, the frictionless ink type recording instrument, shown in Figs. 1, 2 and 3, has been developed. This recorder is designed to parallel, as nearly as possible, the simplicity of the smoked chart type. It will accurately record fractions of milli-volts and is adapted for use as an electric pyrometer. This instrument has been thoroughly tested in practical service and is the result of several years experience with an original patented design of frictionless ink recorder, having a hinged electrical movement carrying a retaining receptacle for the marking fluid, which extends over the path of the recording tip and is provided with means for periodically making contact with the source of the marking fluid and the chart.

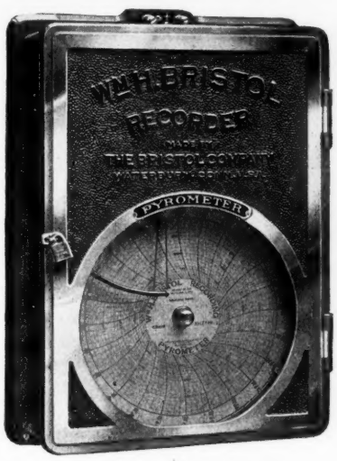


Fig. 1. Bristol Recorder ready for Operation

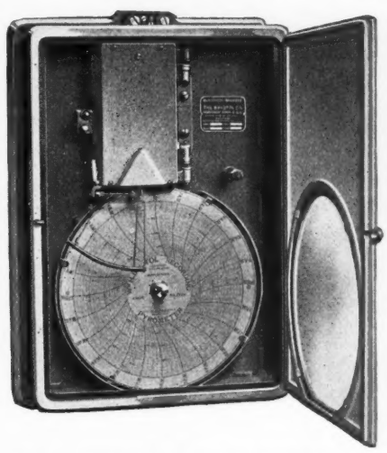


Fig. 2. Interior View showing Galvanometer Movement

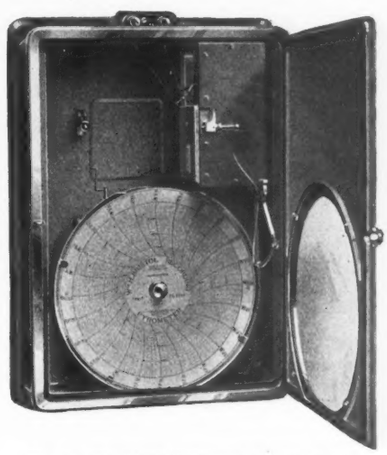
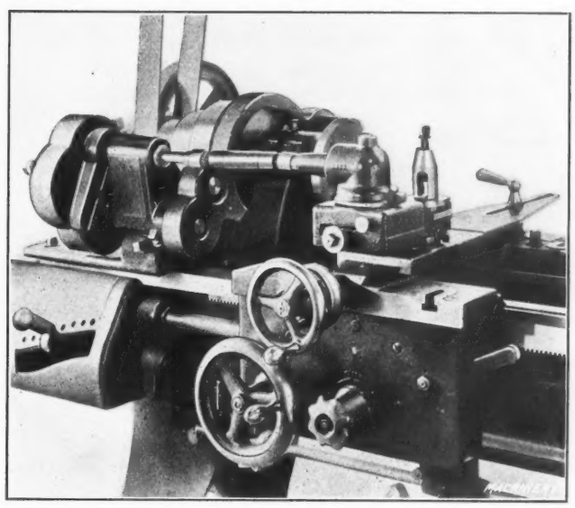


Fig. 3. Electrical Movement swung to One Side for Inserting Chart



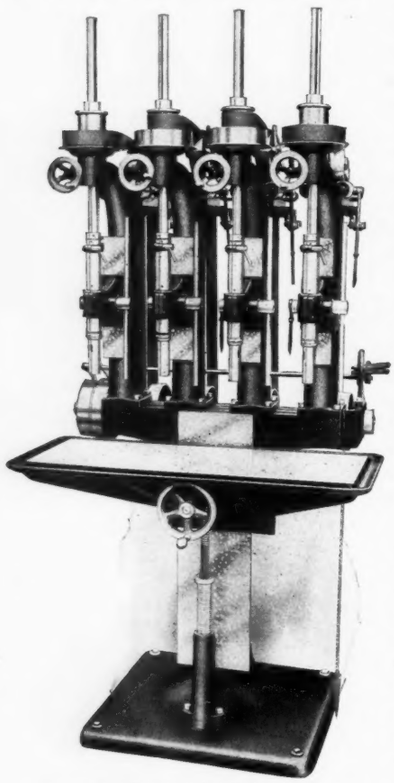
Relieving Attachment applied to Seneca Falls Tool-room Lathe

Fig. 1 shows the recorder ready for operating, and Fig. 2 is an interior view showing the galvanometer movement case hinged to the back of the instrument and carrying the inking pad in front of the recording arm. Fig. 3 shows the sensitive electrical movement swung to one side, for convenience in removing the record and inserting a new chart. A capillary gold tube, open at both ends, is carried at the end of the recording arm and at right-angles to the surface of the chart. The inking pad is suspended from the electrical movement case and is curved to correspond with the arc described by the end of the recording arm. When the movement is swung back into its operating position, as shown in Fig. 2, the recording arm can swing free, thus accommodating itself to the position corresponding to the delicate current which is to be measured. The clock which revolves the chart at the desired speed also automatically presses the inking pad toward the chart every ten seconds, thus bringing one end of the capillary tube into contact with the chart, and the opposite end, simultaneously into contact with the inking pad. A fine dot of ink is left on the chart and the capillary tube is replenished with ink from the pad. The recording arm thus carries a constant supply of ink, and its perfect balance, which is a very important feature, is always retained.

The electrical movements used in these recorders are made especially for the purpose by the Weston Electrical Co. Although the most important applications of these instruments have been as pyrometers, they are also used for electrolytic research, as recording voltmeters and recording shunt ammeters.

HIGH-SPEED DRILLING MACHINES

The Guarantee Machine Co., Grand Rapids, Mich., is manufacturing the design of high-speed ball-bearing drilling machine shown in the accompanying illustration. These machines are made with any number of spindles from one to six, inclusive. The spindle driving cones have two sets of adjustable ball bearings and there are ball bearing thrusts for the spindles. The countershaft at the rear also runs on ball bearings. The idler pulleys on this machine are arranged to rise simultaneously, so that the belts are kept in line with the proper cone step. To change the spindle speed from low to high requires no adjustment other than to raise the idler pulleys, the idler brackets being arranged to allow the idlers to track on either cone without adjustment on the part of the operator. Speed changes are made by means of a lever within convenient reach. Four changes are available, ranging from 450 to 1400 revolutions per minute, with a countershaft speed of 600 revolutions per minute. The idler carriage has an adjusting screw and handwheel located at the front of each head, to take up the stretch of the 1½-inch endless belts, when necessary. The spindles are driven by two splined keys, and have a feed of 6 inches. The sliding heads also have a vertical movement of 8 inches. The spindle bearing in the quill is 10 inches long, and there is an adjustable stop-collar attached to the quill. The table has a 10-inch bearing on the face of the column, and is gibbed to compensate for wear. The three-, four-, five- and six-spindle machines are equipped with raising screws for the table, and the one- and two-spindle sizes can be provided with these screws if so ordered. The belt-shifting device requires a forward movement instead of a side motion, and it can be placed between any of the upper columns.

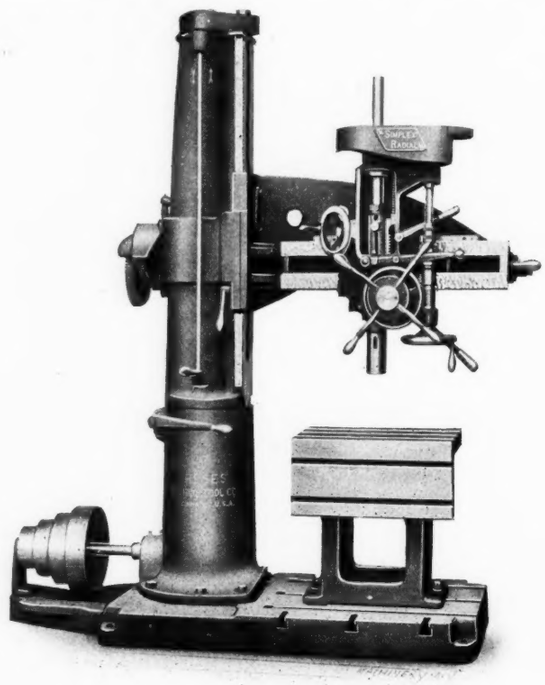


High-speed Drilling Machine built by the Guarantee Machine Co.

SIMPLEX 31- AND 36-INCH RADIAL DRILLING MACHINES

The radial drilling machine illustrated herewith is intended particularly for repair shops or other places where a machine of simple construction is preferable to a more complicated and expensive design. It is built by the Dreses Machine Tool Co., Cincinnati, O.

The column revolves on a roller bearing and is clamped in a fixed position by a single handle. The spindle has a ball thrust bearing and is started, stopped, and reversed by the well-known three-bevel-gear arrangement and a friction clutch. This clutch is operated by a lever seen on the right-hand side under the arm. There is an automatic stop and graduated depth gage, and a quick-return movement controlled by the four handles shown. The feed is all-geared and has four changes which can be made while drilling. A speed and feed plate is attached to the head for the convenience of the operator. The head is traversed along the rail by a rack and spiral pinion arrangment, and it is clamped by a single lever seen above the rail. The table is separate from the column which makes it available for the full horizontal traverse of the spindle. A swinging or tilting table with or without a worm movement can also be furnished.



Simplex Radial Drill built by Dreses Machine Tool Co.

Some of the principal dimensions of the 31- and 36-inch sizes are, respectively, as follows. Maximum distance between spindle and base, 51 inches and 58 inches; traverse of head on arm, 21 inches and 26 inches; traverse of arm on column, 32 inches and 38 inches; minimum distance between column and spindle, 10 inches for both sizes; traverse of spindle, 12 inches for both sizes, maximum diameter of circle the center of which can be drilled, 63 inches and 73 inches; pipe tap capacity for both sizes, 2 inches; standard tap capacity, 1¼ inch; capacity for drilling in solid cast iron, 2½ inches; capacity for drilling in solid steel, 1¾ inch. These machines are also furnished with a speed variator or motor drive.

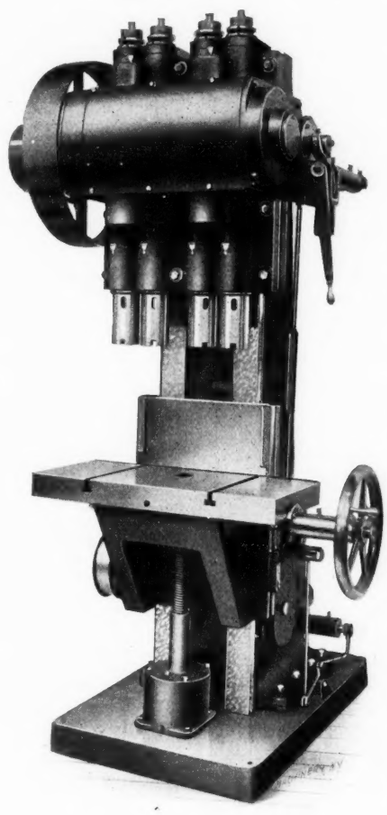
TEMCO ELECTRIC DRILL

The portable electric breast drill shown herewith has a capacity for drills up to ⅝ inch in diameter and it weighs complete 12½ pounds. The driving motor is wound for either alternating or direct current, and a combination winding for either current (of the same voltage) can be furnished if desired. This winding, however, is recommended only when the drill is to be used in various places where the current may change. The motor is reversible, which is convenient when the drill breaks or sticks; this feature is also advantageous for tapping. The switch for starting, stopping or reversing the motor is encased, which excludes all chips and protects the hands of the operator. A single lever on the outside, that is insulated from the current-carrying parts of the switch, serves to control the switch. This lever is spring-seated when in the "off" position, so that the arc is broken the same as in a "snap" switch. This feature increases the durability of the switch points and insures certainty of movement to the operating lever, which is located beneath the handle that extends from the breast-plate, and within easy reach of the thumb and finger. When it is desired to tighten the drill chuck, the spindle can be locked against rotation by swinging it to a right-angle position where it is locked by jaws on the main frame. This drill is manufactured by the Temco Electric Motor Co., Leipsic, O.

Electric Breast Drill

BAKER BROTHERS CYLINDER BORING MACHINE

A cylinder boring machine of recent design, built by Baker Bros., Toledo, O., for the rapid boring of automobile cylinders *en bloc*, is illustrated herewith. In the design of a machine of this type, it is very important to secure a powerful but smooth-running drive with the close center distance required between the spindles. On one of these machines, having four spindles, the center-to-center distance between adjacent spindles is 4 inches and the drive is sufficiently powerful to rough-bore a block of four cylinders 3¾ inches in diameter and 10 inches deep, in one and one-half minute and finish it in one minute. The usual operations in their successive order are rough-boring, "straighten" boring, and finish-reaming. This powerful drive is secured by eliminating friction as far as possible. The horizontal shafts are all provided with Hess-Bright annular bearings, and the vertical shafts with "high-duty" roller bearings. The thrusts are all taken on ball bearings. The drive is through a simple train of spur and bevel gears. The gears are all made of high-grade steel and hardened. The friction losses are said to be so slight that the entire gear train with the four spindles, each having a ratio of 15 to 1 from the primary drive, can be easily turned backward by applying a lever two feet long to the end of one of the spindles. In order to align the spindles perfectly, they are provided with bronze taper bearings with provision for adjusting in case of wear.

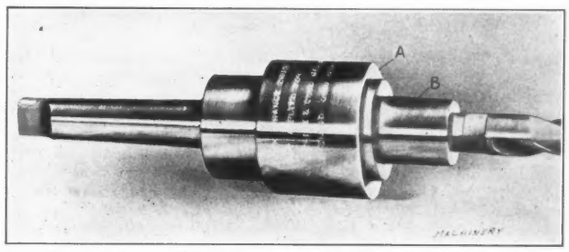


Baker Cylinder Boring Machine

The action of this machine in operation is semi-automatic. After a cylinder is chucked, the starting lever, shown at the upper right-hand side of the machine, is thrown in; this engages the driving clutch, thus starting the spindles and feeding mechanism. The table feeds up with the work until the proper depth is reached, when it automatically trips, the spindles stop revolving, and a quick-return feed is engaged which backs the work away from the cutters and stops when the latter are clear. The entire feeding train contains hardened gearing and shafts running on annular ball bearings with thrust bearings where needed. The table is gibbed on the inner part of the column ways, and there is large ratio between the width and length of the bearing surfaces, thus insuring accurate alignment and freedom of operation.

QUICK-CHANGE DRILL CHUCK

The Machine & Tool Mfg. Co., Cleveland, O., has brought out a type of drill chuck known as the "quick-change chuck." This chuck is intended for use in upright drills and in screw machines or horizontal boring mills. It is very simple and easy to operate, and sockets can be quickly changed without stopping the machine by pushing back the outer sleeve *A*



"Quick-change" Drill Chuck

which allows the socket *B* to fall out (when in a vertical position) or be removed; a new socket can then be inserted in its place, after which the outer sleeve drops down by gravity and holds the socket in place. The chucks and sockets are made of a special grade of steel which is selected for its toughness and wearing qualities. All parts are hardened and ground, insuring accuracy and durability. The chucks are said to be very accurate, and it is claimed that no dirt can enter to interfere with the operation, as all parts are enclosed. These chucks are made in three different sizes.

NEW MACHINERY AND TOOLS NOTES

Reamer: McCrosky Reamer Co., Meadville, Pa. Adjustable reamer made with either right- or left-hand spiral cutting edges. The 2-inch size has an expansion of approximately 3/32 inch, and the adjustment is easily effected.

Drilling Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. Special three-spindle drilling machine designed to drill and tap, simultaneously, the three cored holes in motor contactor pole-pieces. It has a capacity for drills up to 1¼ inch and for taps up to 1 inch in diameter.

Foot-power Grinder: Carborundum Co., Niagara Falls, N. Y. Grinder operated by a one-foot treadle which imparts rotary movement to a vertical, spirally grooved shaft connecting at the top with a horizontal spindle, having carborundum wheels at each end. The grinder has ball bearings and weighs 68 pounds.

Lathe: Von Wyck Machine Tool Co., Cincinnati, O. Engine lathe having a gear box at the headstock end giving three feed changes, and a gear mechanism in the apron giving five additional changes for each variation obtained with the first box referred to, thus making a total of fifteen rates of feed. This number can be extended for either finer or coarser feeds by the use of change gears.

Tap Grinder: Bicknell-Thomas Co., Greenfield, Mass. Tap grinder with capacity for sharpening taps up to 1½ inch in diameter. The tap being ground is held between centers and it is swung past the face of the cup-wheel. The spindle

is driven from a countershaft bolted to the rear of the column. A wheel for general grinding operations may be mounted on the opposite end of the spindle. This machine is sold exclusively by the Wells Bros. Co., Greenfield, Mass.

Ring Wheel Chuck: Gardner Machine Co., Beloit, Wis. Ring wheel chuck for all types of disk, vertical, edge, face and knife grinders. The special features claimed for this chuck are lightness, simplicity of construction, perfect running balance, minimum overhang, and safety in operation. They are built in six sizes for abrasive rings varying from 12 to 24 inches in diameter, and can be interchanged with the regular disk wheels.

Portable Grinder: Ransom Mfg. Co., Oshkosh, Wis. Portable emery grinder consisting of a wide-tired two-wheel truck, carrying a stiff tube about 8 feet long, on one end of which the grinding wheel is mounted. Attached to the same tube on the opposite side of the axle there is a motor which is connected to the wheel by a long belt. A five-horsepower motor is used and it is located so as to counterbalance the weight of the grinding wheel.

Center Drills: J. T. Slocomb Co., Providence, R. I. Combination center drills consisting of a variety of sizes arranged in sets in a nicely finished wooden box. There are eight sizes in all, so that the proper size for a great variety of work is always at hand. All of the Slocomb combination center drills now manufactured are made of semi-high-speed steel, which increases their productive capacity. These combination drills are so well known and widely used that the drill itself is familiar to practically all mechanics, and need not be described.

Spring Dies: National-Acme Mfg. Co., Cleveland, O. This company is placing on the market an improved spring die having S. A. E., (formerly A. L. A. M.) vee and United States standard threads. Dies of special pitch and shapes can also be supplied to order. This company has made, for several years, large quantities of spring or prong dies for use in its "Product department," and now has a fully equipped die department for the manufacture of these spring dies and also the self-opening die-heads and chasers previously described in the June, 1911, number.

Bench Drills: Hisey-Wolf Machine Co., Cincinnati, O. Attachment in the form of a base, column and cross arm for converting hand or breast drills into a machine of the bench type. The cross arm, which is adjustably mounted on the column, has a fixture for holding the drill, and there is a table on the column having vertical and radial adjustment. Portable electric sensitive bench drill, the spindle of which is driven through friction disks. This form of drive makes the tool very handy for small tapping operations, as the motion can be quickly reversed by shifting the driven disk across the center of the driver. This tool is made for either alternating or direct current.

Rack and Gear Cutters: Standard Mfg. Co., Bridgeport, Conn. Worm-gear- and rack-cutting machines, intended for standard work. The rack-cutting machine has power feed, an automatic index and a hand return. It will take work up to 8 inches in width and will automatically cut racks 22½ inches in length, and longer if the work is re-set. The slide carrying the cutter spindle, rises as soon as the cut is completed and clears the blank on the return stroke, indexing at the same time. An automatic stop renders the mechanism idle when the rack is completed. The worm-cutter has a master worm which feeds the work beneath the cutter. This machine is said to be very rapid in its operation.

Horizontal Boring Machine: Barrett Machine Tool Co., Meadville, Pa. Horizontal machine for boring and facing, simultaneously, steam, gas, gasoline, pump and locomotive cylinders. The boring-bar is 5 inches in diameter and has a continuous feeding movement in either directon of 48 inches. It is driven through worm-gearing of the Hindley type which imparts a smooth steady motion. There is a quick-change feed-box, giving feeds varying from 1/32 to 7/16 inch per revolution of the bar. The two facing arms are mounted on the ends of sleeves and are driven by friction. These arms can be started and stopped at will, and when not in use, they do not interfere with the rotation and travel of the bar. The machine is furnished with either a belt or motor drive.

Riveter: Grant Mfg. & Machine Co., 80 Silliman Ave., Bridgeport, Conn. Motor-driven riveter of the spinning type composed of two parts, one of which consists of a cast-iron frame suspended from the ceiling by tie-rods and containing the motor and spindle, while the other is in the form of a pedestal which is bolted to the floor. This arrangement permits the work to be placed in the most convenient position for riveting. Unlike the regular line of riveters built by this company, this machine is operated by a hand lever so located that it does not interfere with the work, but is easy of access for the operator. This machine is especially adapted for riveting automobile bodies, hoods, fenders and other light work which is bulky or irregular in shape. The riveting spindle can be driven by belt or direct by a motor.

Square Hole Milling Machine: R. K. LeBlond Machine Tool Co., Cincinnati, O. Combination milling machine especially adapted for cutting square holes. This machine is of the same general construction as the No. 2 plain type built by this company, and can also be used for regular milling work. The operation of the square-hole attachment is similar in principle to other devices which have been designed for this class of work. A triangular-shaped drill revolves in a stationary master guide which resembles a regular drill chuck. This guide or chuck is fastened directly to the column of the machine. This method of mounting the stationary guiding member is an important improvement over other devices in that it gives the rigidity necessary to withstand the side thrust and eccentric jarring motion of the cutter. The cutter receives its motion from a driving member which allows it to "float" or travel around the square opening formed by the jaws of the stationary master guide or chuck. When the drill is in operation, it describes a movement similar to that obtained with a "three-cornered box cam," which causes the three lipped drill to form a square hole. Holes of any depth within the length of the drill and capacity of the machine can be formed, and a neat square bottom is left in "blind" holes. As it is advantageous, when cutting square holes in tough material, to previously drill a round hole, the machine is provided with an appliance for operating ordinary twist drills. The square-hole attachment can be removed quickly when it is desired to use the machine for regular milling work.

* * *

DRAFTSMEN AND DESIGNERS

The following extract from a letter written by an experienced machine designer to a young man just entering the drafting-room, who had been asking for advice, may be of interest to young men in general who look forward to drafting work as the ultimate goal of their ambition.

"As you are young at the business, perhaps I had better explain the term "draftsman" to you. This term has a very wide meaning and includes anyone, from a man who can make a drawing to scale from a free-hand sketch, to a man who can design as well as draw a printing press, for instance. The first one is a draftsman pure and simple, while the second one is a designing draftsman, who can do things the first man never heard of. Properly designated, the first man is a draftsman, while the second is a designer. This distinction, however, is not usually made except in salary, and anyone working on drawings (not tracings) is known by the general term of draftsman.

"A designer must be a specialist, because neither you nor anyone else will ever know how to design anything, even in a very limited field, and there is no known rational method of design which can be studied in the same way as we can study mathematics or physics.

"The following may give you an idea of salaries. A draftsman's salary runs all the way from $50.00 to $150.00 per month. A detailer gets from $50.00 to $100.00 a month, the figure depending upon the man's ability and experience. A salary of about $110.00 per month calls for a man who can make the simpler designs for a detailer, the latter in that case getting perhaps about $60.00 a month. A salary of $125.00 per month calls for a man who can design anything in his line expected of a man in a drafting-room. If he receives $150.00 per month he must be able to look after the designing and detail work of men working under him."

* * *

Tests made by Arthur D. Little, Inc., chemists and engineers of Boston, Mass., indicate that a great deal of money is wasted on lubricants because "good brands" are bought at any price. In one case an analysis of the cylinder oil for which a plant was paying 65 cents per gallon showed that, although a good oil, it was no better for the purpose than oils for which many large corporations are paying as low as 25 cents per gallon. A thoroughly good oil can be bought to rigid specifications at prices less than one-half of those usually charged for cylinder oils known by some special name. The saving thus accomplished is obvious.

* * *

Coes Wrench Co., Worcester, Mass., advertised a draftsman's eraser, belt or lace knife in MACHINERY, 1902. Recently an order was received for same from a party that enclosed a clipping of the original advertisement and referred to its date. This case is only one showing that the useful life of an advertisement in a valued journal is not limited merely to a few weeks or months.

A QUESTION IN SHAPER DESIGN

The article on the quick-return motion of the Stockbridge shaper, published in the October number, does not, in our opinion, properly set forth the merits of a plain slotted crank as compared with the more complicated quick-return mechanism previously described. Will you allow us to point out some of the objectionable features of this mechanism as applied to the back-geared crank shaper?

Fig. 1 shows the construction of our simple quick-return mechanism. It will be noted that there is but one bearing

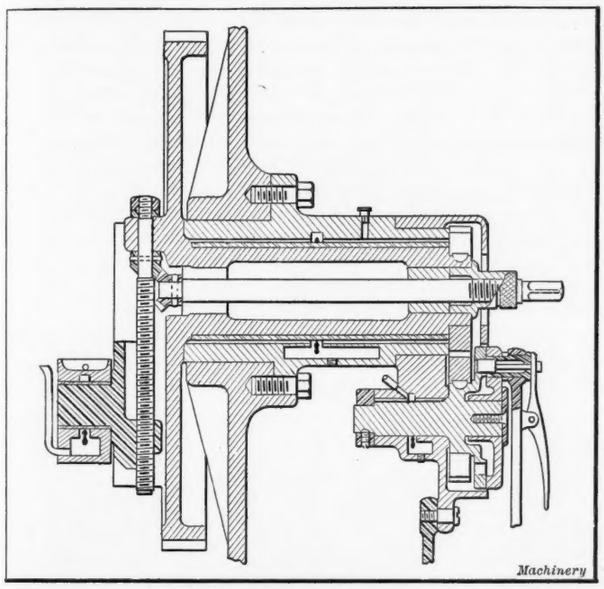


Fig. 1. Bull Gear and Crank of Queen City Shaper

surface for the bull-gear as compared with ten bearing surfaces in the complicated quick-return mechanism which will be referred to later. The single bearing surface is that of the bull-gear hub in the column. This journal is hardened and ground and has a self-oiling device giving flooded lubrication which prevents it from wearing elliptical. It should be noted that the gear teeth are radial from a point within the bearing, to reduce the overhang as much as possible, and that the hub is very long to offset the overhang.

Fig. 2 shows the four principal parts of the crank mechanism previously illustrated, and Fig. 3 is a reproduction of

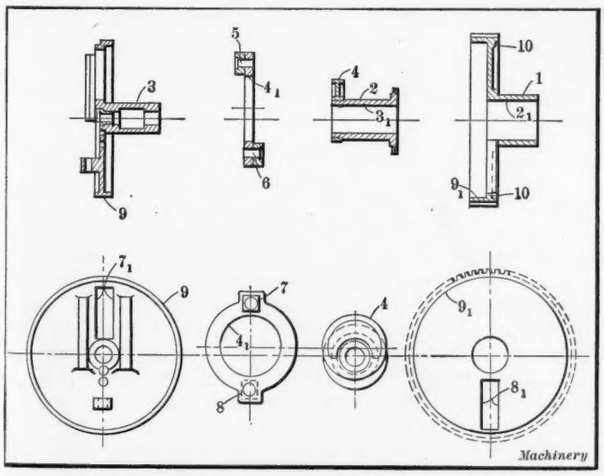


Fig. 2. Principal Parts of Mechanism illustrated in Fig. 3

the assembled sectional drawing shown in the original article. The ten bearing surfaces, all of which are in action while the tool is cutting, are as follows: No. 1 runs in the column and corresponds to the center hub bearing of the simple quick-return mechanism, but although this bearing must take the full thrust of the cut, it is comparatively short. The other bearing surfaces are numbered so that the journal and its bearing can be easily located, the journals being indicated by Nos. 2, 3, 4, etc., and the corresponding bearings by 2_1, 3_1, 4_1, etc. No. 10 is in contact with a flange on the column.

Is it necessary to point out that these nine extra bearing surfaces increase friction and wear? It should also be noted that two of these bearings are flat rubbing surfaces (7 and 8) which act as a brake, and some of the radially moving parts are placed close to the periphery of the bull-gear, which is more objectionable from the standpoint of friction increase, than a well designed hub bearing. We should like to refer right here to your most excellent and timely editorial in the October number, entitled, "Complicated vs. Simple Machine Designs."

We freely admit that the quick-return mechanism illustrated in Fig. 3, does bring about the desired effect, in that it has a very quick return and an even cutting speed, but, at what a sacrifice of simplicity and loss of power! Reference is made to some tests published in the November, 1909, number of MACHINERY. While looking up these tests, which show the horsepower required for removing metal, please refer to the tests published in the March, 1909, number of MACHINERY, and compare the horsepower required to remove about four times the amount of metal. These two tests are compared on page 37 (advertising section) of the December, 1909, issue of MACHINERY.

Let us ask if an even cutting speed is desirable in planing? If so, why is Mr. Powell of the Powell Planer Co. so enthusi-

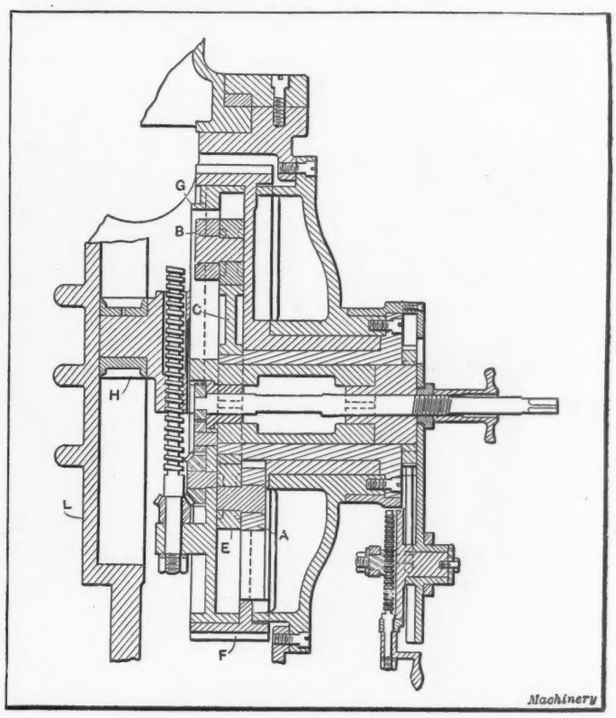


Fig. 3. Crank Mechanism of Stockbridge Shaper

astic over his accelerating cut planer? Furthermore, it has been shown time and again that a quick return, in planing, is not nearly so important as the speed at which the cut can be taken. If the quick return is so important, why the variable speed planer with a constant return? The accelerating motion of the shaper is especially valuable, in that it reduces the shock of the tool when entering and leaving the work. The real question at issue is, how much work can be produced in a given time and at what expenditure of power? We claim that a shaper with the simple quick return, will not only take a much heavier cut or the same cut at a much higher speed, but it will make more full cycles of the ram per minute.

Cincinnati, O. QUEEN CITY MACHINE TOOL CO.

[The article referred to in the foregoing criticism was not published in order to exploit the advantages of the quick-return mechanism which was the subject, but rather to analyze the motion; in other words, the article was more on kinematics than machine design. The movement obtained with the Stockbridge quick-return mechanism is, in our

opinion, preferable to that derived from a plain slotted crank, as far as the motion itself is concerned, but any advantage resulting from a more constant cutting speed or quicker return than is imparted by a plain crank may, of course, be more than offset by the additional complication required. A gradual acceleration at the beginning of a cut is, no doubt, desirable in that it diminishes the shock. The advantage of this feature, however, is obtained in a somewhat lesser degree with a shaper having a constant cutting speed, because the accelerating period extends through a greater part of the stroke than would be required for tool clearance. After the cut is started, there is no reason why the velocity should vary. With the accelerating cut planer, the impact between the tool and the work is reduced by a slow start at the beginning of the cut; the speed is then increased but it remains constant for practically the entire cutting stroke. The question is: Are the disadvantages of the variable speed and slower return of a plain crank, great enough to warrant the addition of a more complicated mechanism that will give a constant cutting speed and a quicker return? We do not know.—EDITOR.]

* * *

SCIENTIFIC MANAGEMENT OF ARSENALS

According to newspaper reports, the War Department is making an investigation with a view to the introduction of scientific management at the army arsenals. The system has been tried out in the arsenal at Watertown, N. Y. As an example of the working of the system and of the results achieved, the following is abstracted from a report of Major-General Crozier, chief of the Bureau of Ordnance. A certain mold under the day wage system had taken 53 minutes to make, while a time study indicated that the molds could be made in 24 minutes each. A premium was, therefore, offered for every minute under 50 minutes in which the mold was made, and a workman was put at the task, following the suggestions given by the expert employed. This workman made the molds at an average of twenty minutes each. The castings from the molds so made could not be distinguished from the old ones. At one time, it is reported, this man did a whole day's work at the rate of one mold every fifteen minutes, and he once was observed to complete a mold in ten minutes. When these molds were produced in 53 minutes each, the labor cost, including helper and all other charges, was $1.17 each. When they were made in 20 minutes, the cost of each was reduced to 54 cents. There was thus a saving of 63 cents on each mold, and the net daily saving as the result of one man's work in this particular case was $15.10. When the molds were made at the rate of 53 minutes each under day wages, the molder's pay was $3.28 a day; when made in 20 minutes, the molder earned $5.74 a day.

THE SPHINX VALVELESS GASOLINE MOTOR

By R. W. HUTCHINSON, JR.*

After the design of internal combustion motors appeared to have been standardized and a type in which poppet or mushroom type valves formed an indispensable part had been adopted, the design was revolutionized a couple of years ago by the placing on the market of an engine somewhat erroneously known as a valveless motor. In place of poppet valves the new type of motor employed sliding or rotary sleeves uncovering ports in the cylinder walls. It is generally conceded that this sliding valve type of motor has the advantage of silence, especially at low engine speeds, and that at these speeds it develops greater power than the average poppet valve motor. It has the disadvantage, however, of greater complication, higher cost, and the absence of "foolproofness" found in the standard poppet type motor. A type of engine known as the "Sphinx" motor, which has all the advantages of the slide valve type, together with the best features of the poppet valve engine, has recently been developed. In this engine a split ring having a sufficient reciprocating motion within the cylinder to cover and uncover the intake and exhaust ports in the cylinder walls, is made use of.

The accompanying illustrations show various views of this engine. Fig. 2 shows a single cylinder type in which *A* is the intake port and *B* the exhaust port. At *C* is shown the split ring which regulates the inlet and exhaust at *M* and *N*. It will be seen that the cylinder differs from the usual poppet valve type by having no outstanding chamber to receive the valves. Down one side of the cylinder near the head of the casting are the two ports, and on the opposite side is a camshaft housing cast integral with the cylinder. The cylinder head is separate, and the spark plug is mounted in the center of the head, which is the best possible position. The split sliding ring consists of a gray iron casting having a length of face of 1½ inch for a motor of 4-inch bore and 5½-inch stroke. As shown in Fig. 4, this ring is provided with a hollow spindle or bearing block for receiving the rocker arm. The depth of the ring is greater around the hollow spindle than at any other point, this increased depth being necessary in order to cover the slot through which the rocker arm is passed from the outside to the inside of the cylinder. This slot in the cylinder wall is never uncovered. By means of a bell-crank *H* and an ordinary type of camshaft, as shown at *E*, Fig. 1, the necessary reciprocating motion of the ring is obtained to insure the different phases of a four-cycle motor.

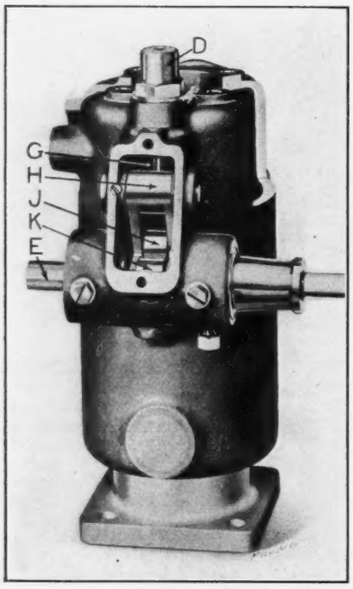


Fig. 1. Side View of Cylinder of Sphinx Gasoline Engine

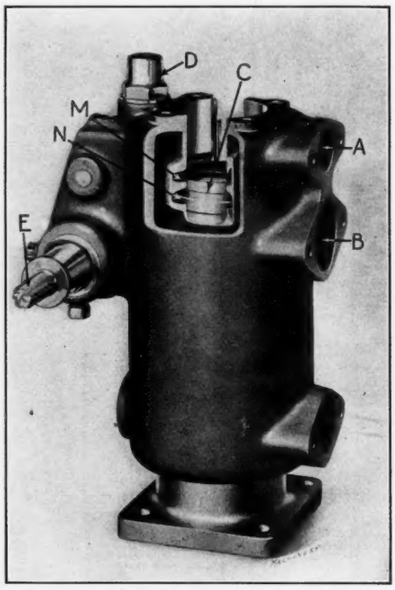


Fig. 2. Cylinder with Part of Metal cut away to show Sliding Ring

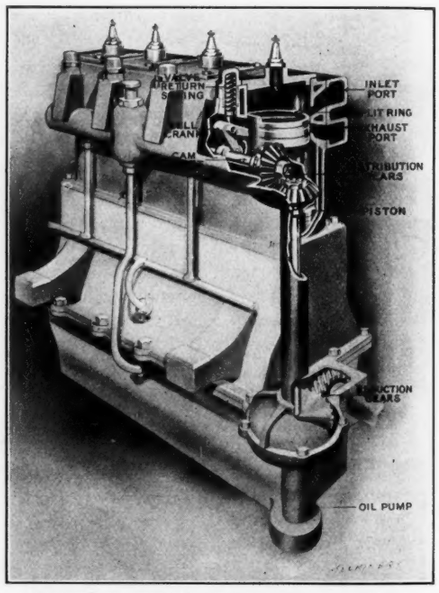


Fig. 3. Four-cylinder Engine shown partially in Section

*Address: Care of Sphinx Motor Co., Room 2006, 30 Church St., New York.

One of the most valuable features of this motor is the large valve area obtained without the complication attending the use of large diameter poppet valves. In an investigation of specific designs it was found that the Sphinx motor had port areas of more than twice the areas of motors with poppet valves, for engines of equal bore and stroke. The walls of the sliding ring are in direct contact with the water jacketed walls of the cylinder, and work under practically the same favorable conditions as piston rings. As shown in Fig. 4 the short arm of the bell-crank carries a roller. This roller *J*, Fig. 1, is in constant contact with the face of cam *K* on shaft *E*. As the boss of the cam lifts the roller, the ring is raised. The return of the ring is obtained in practically the same way as in the case of a poppet valve, namely by means of a coil spring as indicated in Fig. 3. The housing for this spring is shown at *D* in Figs. 1 and 2.

The serious objection made to motors of the sleeve or rotary valve type—that in the case of defective lubrication the valve mechanism would seize and probably ruin the engine—is not applicable to this motor. If the spring should be unable to return the ring to its normal position, the exhaust port would merely be left open, and this would be far less serious a matter than the breakage of a valve or the seizing of a valve stem in its guide.

The walls of the cylinders are cooled all the way up to the head, but the head itself is not water-cooled. The lubrication is taken care of in a satisfactory manner. All the main bearings receive their oil supply under pressure, and the crankshaft is bored out to allow a supply of lubricant to reach

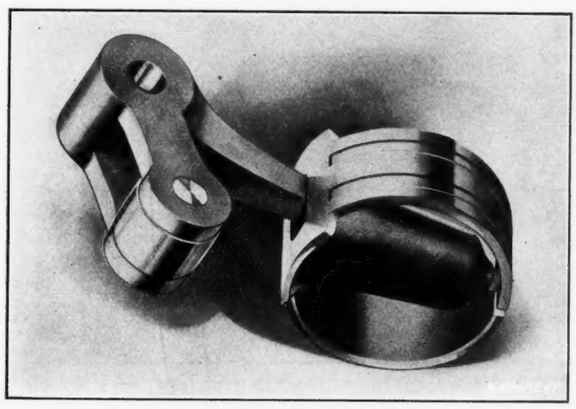


Fig. 4. Sliding Ring and Bell-crank

the connecting-rod ends. The oil thrown out from the bearings is sufficient for proper lubrication of the cylinder walls.

Rotation of the camshaft can be obtained in several ways, one of these being by means of a vertical shaft at one end of the engine, as shown in Fig. 3. This shaft is driven from the main shaft by means of helical gearing and engages the camshaft by means of bevel gearing. On the lower end of the vertical spindle is the oil pump, drawing its supply of lubricant from the base of the crank chamber. The motor is practically silent in operation, as there are but one pair of bevel gears and no valves causing a tapping noise as they come into contact with their seats, nor any tappet rods striking the ends of the valve stems. The motor will remain silent after long use, there being practically no parts which will cause noisy action as the result of wear.

The nature of the ports and the design of the split ring allow the valves to open quickly and to remain with the maximum of opening for a long period. On the 4 by 5½-inch four-cylinder type, the exhaust is closed at the upper dead center. During the first 60 degrees the opening of the intake port has attained an area of approximately 2.3 square inches. It is gradually increased until the maximum of about 2.6 square inches is obtained at 90 degrees. The intake port now gradually closes until it is completely closed at 18 degrees after having reached the lower dead center. The exhaust opens 32 degrees before the lower dead center is reached, obtains its maximum opening at the lower dead center, and is closed at the upper dead center.

CRAMER PROCESS FOR HARDENING HIGH-SPEED AND CARBON TOOL STEEL

An interesting process for hardening steel, especially high-speed steel has been developed by Cramer & Longo, 933 East Ave., Belvidere, Ill. The method is cheaper than the methods ordinarily employed, and the results obtained are remarkable. As the process has not yet been fully covered with patents, detailed information is not yet available, but some of the interesting results obtained deserve to be mentioned. Formed tools for screw machine work, for example, can be hardened without any distortion and can be put to work without polishing or grinding after hardening. Even the cutting edge can be sharpened before hardening, so that the tool can be placed in the machine where it is to be used immediately after coming

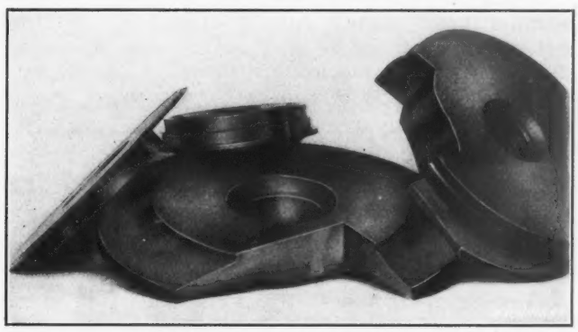


Fig 1. Forming Tools hardened by the Cramer Process. No Sharpening after Hardening is required

out of the hardening bath. As a notable example, it is stated that a hollow ground razor had been hardened by this method and used for shaving without stropping. Another advantage of the process is that it does not require a skilled mechanic to accomplish good results, but any man of ordinary ability can acquire enough experience to turn out good work in a few days.

The accompanying illustrations Figs. 1 and 2 shows some examples of work that has been hardened in this manner. The screw machine forming tools shown in Fig. 1 were put to work immediately after having been hardened, as was also the milling cutter shown in Fig. 2.

It would seem that this method would be of considerable value in making it possible to use high-speed steel satisfactorily for keen-edged tools which cannot be ground after hardening, such as taps, dies, knurls, etc. In the past, the great difficulty with these tools has been that on account of the

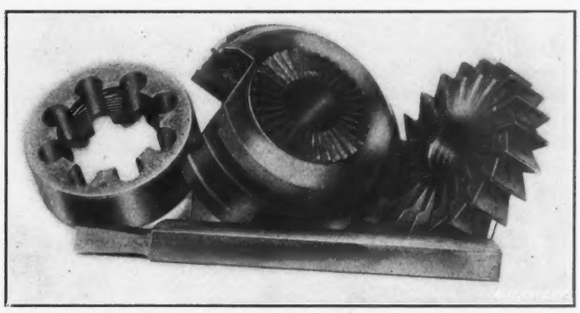


Fig. 2. Other Examples of Work hardened by the Cramer Process

high heat to which high-speed steel must be heated in order to be properly hardened, the delicate edges of the tools were fused before the remainder of the tool had acquired the proper hardening heat. With a method where regrinding of the tool is obviated, this difficulty is entirely avoided. It would also seem that the process would be of great value for hardening steel gears, as there is no distortion of the hardened object, and the present difficulties of automobile concerns with regard to the distortion of hardened gears are well known. The process promises to mark one of the epochs in the hardening of steel.

* * *

More than one-third of the gold production of the world came from Transvaal in 1910. The United States contributed about 20 per cent of the total, and Australia, 14½ per cent.

POINTS IN THE OPERATION OF THE "LO-SWING" LATHE

The "Lo-swing" lathe, manufactured by the Fitchburg Machine Works, Fitchburg, Mass., was described in MACHINERY in the November, 1905, issue. Improvements upon this design have been later described in the September, 1907, and the May, 1909, numbers. In June, 1909, an article entitled "Operations performed on the Lo-swing Lathe" was also published, giving a description of the methods used in turning work adapted to be machined on this lathe. In the present article therefore, it is not proposed to describe the machine itself, but to give a few points with relation to its operation, in order to indicate how the highest efficiency may be obtained by the use of a machine of this type.

As may be remembered from the description previously published, the "Lo-swing" lathe is adapted for the turning of shafts, axles, and similar work, not exceeding 3½ inches in diameter. The usual cross-slide is eliminated, and the adjustment of the tools is obtained by a micrometer adjusting

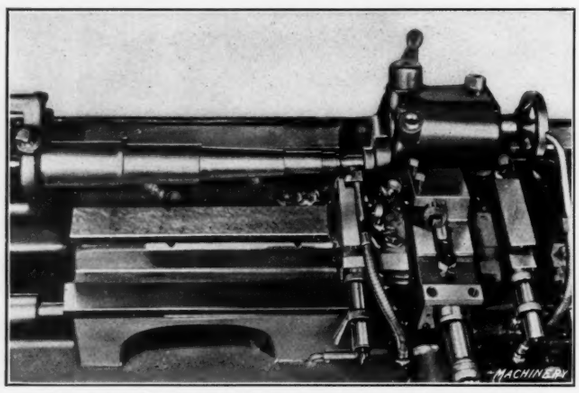


Fig. 1. The "Lo-swing" Lathe in Operation, with Carriage slid by Tailstock

screw bearing against the end of the tool, which is itself placed in a heavy tool-holder. This construction reduces vibration at the cutting point, and permits higher speeds and greater depth of cut. The main feature in addition to this is the facilities provided for "multiple" turning, that is, the turning of a number of diameters simultaneously, and it is in cases where the work must be turned on centers to several

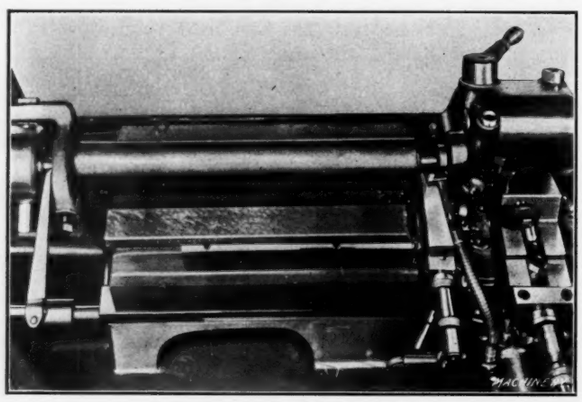


Fig. 2. The Indicator in Use

different diameters or tapers that this machine has a decided advantage over the engine lathe.

The tailstock is of the over-hung construction, being cut away at the front, thus permitting the carriage to slide by to facilitate removal of the work without disturbing the adjustment of the tools. This feature is illustrated in Fig. 1. The carriages accommodate from one to six tools each. The stop-rod on the lathe, with its stop-collars, engages projecting pins on the carriages which, in turn, throw out the carriage feed. In Fig. 2 an indicator is illustrated which is located upon an arm that swings from the end of the stop-rod. In cutting off work and centering, there are apt to be slight variations either in the length of the pieces or in the depth of the centering. Variations of either kind would result in differences in the finished work; therefore, when a piece is placed upon the centers, this indicator arm is thrown up to the position shown in Fig. 2. The bearing end of the indicator is placed against the end of the work, and by means of a small

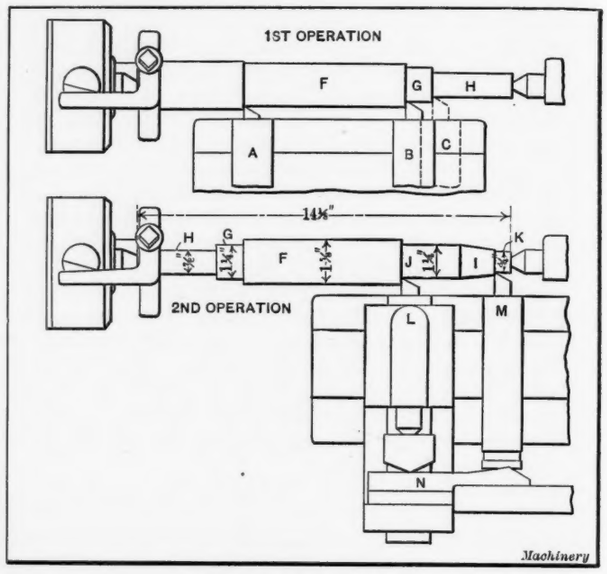


Fig. 3. Arrangement of Tools

lever on the stop-rod, it is adjusted until the indicator needle is central. This adjustment is accomplished by means of a coarse-pitch thread in the left-hand bearing of the stop-rod. It will be seen that in this way all pieces are turned with relation to the end face of the work, and if, as is often necessary, the work is reversed on the centers and turned from the opposite direction, the indicator is brought into play

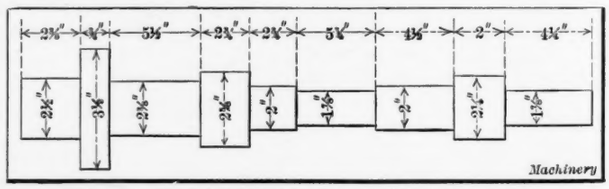


Fig. 4. Example of Work done in the "Lo-swing" Lathe

again, being used against the nearest shoulder left by the previous operation.

Setting up and Starting a Job of Multiple Turning

When it is required to set up the lathe for a new job, templets must first be made for the tapering parts of the work.

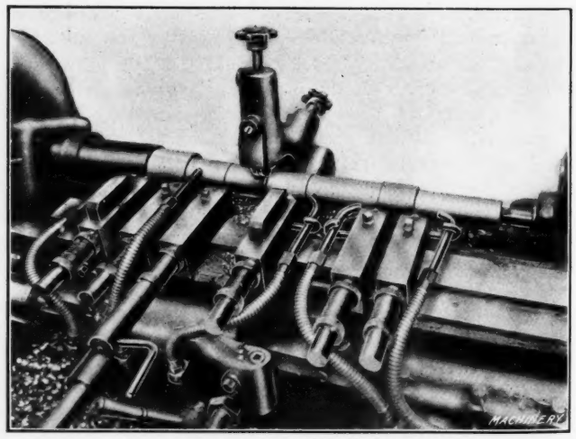


Fig. 5. Work shown in Fig. 4 being turned

These templets are used in connection with the taper attachment, and are made from steel ½ inch thick. Templets are also made for curves or other irregular sections that must be produced. The templets may be made to turn the work partly straight and partly tapered, as indicated by the diagrammat-

ical view in Fig. 3. According to the nature of the work, one or both of the carriages will be required.

Fig. 3 illustrates clearly the way in which an average job of multiple turning is done. In setting up the tools for the first operation, the tools *A* and *B* are located on the first carriage at the exact distance apart that the shoulders must measure on the finished piece; then a stop-collar is located on the stop-rod at the proper place to throw out the feed of the forward carriage at the exact point where the first

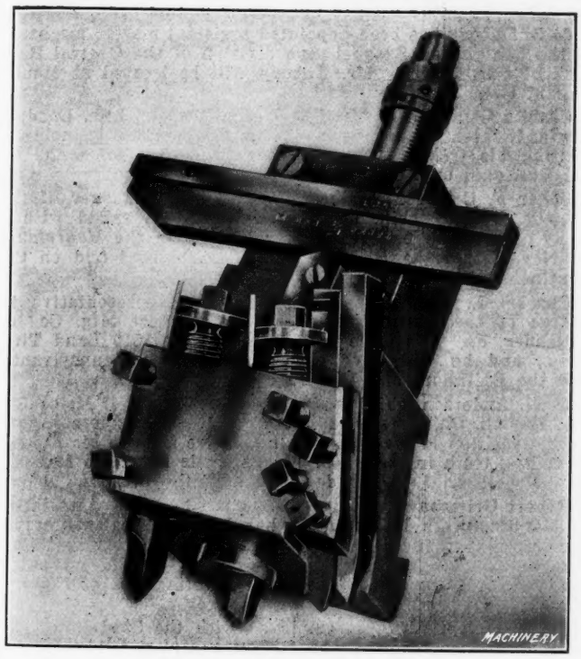


Fig. 6. Special Form of Tool Block

shoulder must be located with relation to the end of the bar. The tools must also be located by means of the individual micrometer adjustments provided for each tool, so as to turn each portion to its proper diameter. The rear carriage is finally set up with a single tool adjusted to turn section *H*. The stop-collar for the rear carriage is located on the stop-rod to throw out the second carriage feed when section *H* has been turned to the proper length. All the shafts to be turned pass through this operation, and then the machine is set up as shown in the lower view in Fig. 3 for the second operation.

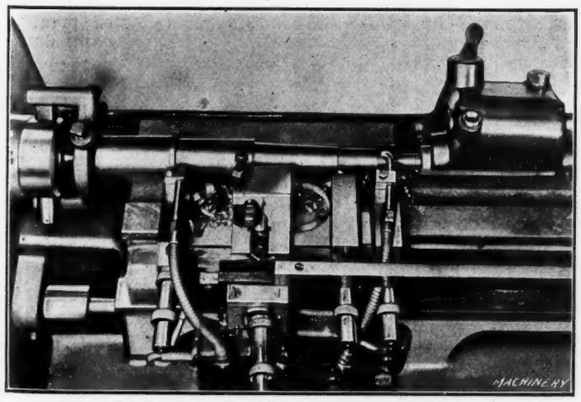


Fig. 7. Tool Arrangement for an Average Piece of Work

In this case the forward carriage only is used and the taper cutting attachment is brought into action. The templet *N* guides tool *L* in turning sections *I* and *J*. Tool *M* is adjusted on this carriage to turn part *K*. The shafts are now all finished by this operation, the automatic measuring device previously referred to being used against the shoulder of section *G* to obtain accurate results.

In turning a piece such as shown in Fig. 4, it would be impossible to obtain square shoulders on the recessed portions without a previous "necking" operation, which consists in taking a square cut to form such shoulders as are at the ends of the recesses. Two tools are used in "necking," the cutting end of the tools being similar to the points of ordinary cutting-off tools.

Often when work is slender, and especially when heavy cuts are to be taken, it is advantageous to spot a central section to receive the steadyrest; in some cases a longer section is turned and the follow-rest used, the same as in an ordinary engine lathe. The piece shown in Fig. 4 is turned from a machine-steel forging of 0.65 per cent carbon steel. The tools used for turning this piece are shown in Fig. 5.

A special tool used in the lathe is shown in Fig. 6. In addition to the taper cutting attachment and the extra tool shown at the left, this special tool block carries two additional tools at the right. The reason that a special tool block is not used for these tools is because of their close spacing, which necessitates that the tools be held in the same tool block with the tool for the taper turning.

One of the most important features is an ample supply of cutting compound for cooling the tools. This is supplied by means of a pump within the head of the machine whence the compound is pumped to supply a pipe for each carriage. From these supply pipes, metal-cased flexible tubes convey the lubricant to the cutting points. The flow from each of these branch pipes is controlled by valves. This arrangement is clearly indicated in Fig. 5. Fig. 7 shows an illustration of an average turning job, of the type for which the machine is adapted, being carried out on the lathe.

* * *

MODERN WELDING METHODS

On account of the wide interest in modern welding methods, the monthly meeting of the American Society of Mechanical Engineers, held November 14 at the Engineering Societies Building, New York, was devoted to the presentation of papers and discussion on the autogenous, electric, and thermit processes of welding. Representatives of both the makers and users of apparatus for welding by the processes mentioned participated in the discussion. The subject was introduced by Mr. H. R. Cobleigh of the International Steam Pump Co., New York, who dealt principally with apparatus for oxy-acetylene and oxy-hydrogen welding. The origin and principles of the various processes were referred to, and illustrations of the development of the blow-pipe and apparatus for autogenous welding were shown.

Mr. G. E. Pelissier of the Goldschmidt Thermit Co., New York, presented a paper on "Thermit Welding" followed by a series of moving pictures showing the work of welding rail joints under ordinary working conditions on the street. In the application of the thermit process two distinct methods are employed. In one case the heat of the chemical reaction of the burning thermit is utilized for obtaining a welding temperature of the parts which are then forced together. In this case the process involved is that of butt-welding. This method is chiefly applied for welding pipes, tubes and small rods. Pipes from 1 to 6 inches in diameter, and rods up to 2 inches in diameter can be advantageously welded by this method. The strength of the welded section is from 80 to 90 per cent of the strength of the solid pipes or rods. In the other method, used for large work particularly, the ends of the pieces to be united are not forced together, but are merely fused and united by the molten metal resulting from the reaction of the burning thermit which amalgamates with the molten metal of the ends to be welded together. In the first method mentioned the ends are filed or machined carefully to fit. In the second method, again, the parts are not brought close together, but a space of ½ inch to 2 inches is allowed for the free flow of the thermit metal. The faces of the metal may then be rough, and molds are used around the parts to be welded.

"Electric Arc Welding" was treated in a paper by Mr. C. B. Auel of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. The three processes dealt with were the Benardos, Salvianoff, and Zerener. The latter process, which consists in using two carbon electrodes for producing welding heat in the parts to be welded, and which has sometimes been called the electric blow-pipe method, is not used at all in the United States, and only to a very limited extent abroad. The Ben-

ardos process is perhaps most commonly used, and consists in using one of the objects to be welded as one electrode, while the other electrode is of carbon. In an endeavor to prevent the formation of hard welds sometimes produced by the Benardos process, Slavianoff substituted a metal electrode for the carbon, this metal electrode usually being of the same material as the metal welded. Considerable attention is required with regard to some details when using this method. In welding iron or steel, the electrodes should be of soft iron from ⅛ to ¼ inch in diameter and about 12 inches long. The current should be of from 125 to 175 amperes with 25 to 30 volts across the arc. The length of the arc is usually from 1/8 to 3/16 inch, while in the Benardos process the arc is from 3/4 to 1 inch long. The Slavianoff process is used where the strength of the weld is of importance.

The Benardos process has several advantages over other processes. It is cheaper and permits more rapid work, and is especially used for rough, large work where appearance and strength are not of prime importance. Mr. Auel stated that the oxy-acetylene and oxy-hydrogen processes are superior to the Benardos electric process in the average strength of welds and in the smoothness of finish, but these advantages are, in the majority of cases, obtained only by higher cost.

A great number of the men connected with the companies manufacturing welding outfits participated in the discussion. However, a detailed review of the papers presented has not been deemed necessary as the various processes have been completely treated in the columns of MACHINERY during the past years.* The possibilities of these various welding processes have hardly been taken advantage of to the extent that seems practicable and economical. The processes are by no means limited to repair work, as is very commonly assumed, but are revolutionizing many practices in regular manufacturing.

* * *

MATTER REDUCED TO THE MOLECULE

In a paper on "Deflocculation" read by Dr. E. G. Acheson, of Niagara Falls, N. Y., the well-known inventor of carborundum, Acheson graphite, etc., before the London Society of Chemical Industry, the theory and practice of deflocculation was dealt with in an interesting manner. One of the particular points of interest brought out by Dr. Acheson was that lamp-black treated by his method would produce an indelible printing ink. At the close of his address Dr. Acheson made a most radical claim to the effect that his process reduces matter to the molecule. An article on deflocculated graphite appeared in the July, 1907, number of MACHINERY.

* * *

DECISION IN MOLDING MACHINE PATENT CASE

The United States Circuit Court of Appeals has handed down a decision in the patent infringement suit brought by the Tabor Mfg. Co., Philadelphia, Pa., against the Mumford Molding Machine Co., Plainfield, N. J. The patents involved covered improvements in molding machinery. Judge Lanning did not sustain the contention of the plaintiff, but decided that there was no infringement on any of the patents under consideration.

*The following articles previously published in MACHINERY on the oxy-acetylene process and the apparatus used for same may be referred to: "The Oxy-Acetylene Process and the Steel Car," May, 1911; "Goodyear Oxy-Acetylene Equipment," December, 1910; "Dangerous Oxy-Acetylene Apparatus," May, 1910; "Autogenous Welding Equipment for Light Work," July, 1909; "Autogenous Welding as a Means for Repairing Cylinders," April, 1909, engineering edition; "The Application of Autogenous Welding to Automobile Repairs," December, 1908; "Autogenous Welding," November, 1908, engineering edition; "Oxy-Acetylene Process of Metal Cutting and Autogenous Welding," October, 1908; "Autogenous Welding," July, 1907, engineering edition; "Acetylene Gas for Welding," September, 1906, engineering edition. The principles and application of electric welding and machines for doing work of this kind have been treated in the following articles previously published in MACHINERY: "Point and Ridge Method of Electric Welding," September, 1911; "Toledo Spot Welding Machines," June, 1911; "Electric Butt-Welding," October, 1910, engineering edition; "Electric Welding of Copper, Brass and Aluminum," March, 1910, engineering edition; "Toledo Electric Welding Machines," September, 1909; "Electrical Welding," February, 1909; "Electric Welding of Dissimilar Metals," July, 1908; "Some Examples of Electric Welding," April, 1908. The thermit process has been dealt with in the following articles: "Welding a Large Crankshaft with Thermit," July, 1910; "Novel Use of Thermit," February, 1908, engineering edition; "Thermit Repairs of Steamship Stern Frame and Rudder Post," December, 1907; "Thermit Welding of Locomotive Frames," August, 1905; "The Thermit Process," March, 1903; "The Use of Thermit for Repairing," March, 1903.

PERSONALS

George L. Spence has been appointed sales manager of the Pratt & Cady Co., Hartford, Conn.

G. P. Blackiston entered into the employ of the United Steel Co., Canton, Ohio, as advertising manager, on November 1.

E. G. Acheson, of Niagara Falls, N. Y., read a paper on "Deflocculation," on November 7, before the London Society of Chemical Industry.

F. H. Meyers has been appointed assistant superintendent of the Standard Welding Co., Cleveland, Ohio. Mr. Meyers has for many years been in the employ of this firm.

A. B. Enbody has been appointed assistant master mechanic of the Lehigh and Susquehanna division of the Central Railroad of New Jersey. Mr. Enbody will be located at Mauch Chunk, Pa.

Charles Churchill of Charles Churchill & Co., Ltd., London, England, recently spent a month in this country, principally visiting his friends and relatives. He sailed for home on the *Lusitania* on November 29.

Coker F. Clarkson, secretary and general manager of the Society of Automobile Engineers, New York, sailed with a party of automobile engineers for Europe on the *Mauretania* on November 1. Automobile plants in England and on the Continent will be visited.

Charles E. Hague has been appointed representative in charge of the Philadelphia office of the Best Mfg. Co., of Pittsburg, Pa. His office will be located at 1510 Land Title Bldg., and he will have charge of Eastern Pennsylvania, and the Baltimore and Washington territory.

H. N. Anderson, chief engineer of the Speedwell Motor Car Co., Dayton, Ohio, resigned December 1. Mr. Anderson gave up his position in order to give his entire time to his process of rolling teeth in steel gear blanks while hot. See MACHINERY, November, 1910, for description of the process.

Robert Grimshaw, who represents the National Association of Manufacturers in Germany, has had the Foster pressure regulators introduced on the cars of the Roumanian State railways, and the first lot of these is being built in Austria under the patents of the Foster Engineering Co., of Newark, N. J.

A. M. Welch, who was employed with the Studebaker Co., of South Bend, Ind., for about eight years, and who for the past year has been manager of the commercial car department of the H. H. Franklin Mfg. Co., of Syracuse, N. Y., has entered the employ of the Stevens-Duryea Co., of Chicopee Falls, Mass., for which company he will take up territorial work.

George Walworth Hayden has been elected president of the Pratt & Cady Co., Hartford, Conn. Mr. Hayden, who has been in the valve business for twenty-three years, having started in this work with the Crane Co., of Chicago, Ill., entered the employ of the Pratt & Cady Co. two years ago as general manager.

Frank L. Sessions has been made superintendent of the Standard Welding Co., Cleveland, Ohio. Mr. Sessions graduated from the Worcester Polytechnic Institute in 1889. He is a member of the American Society of Mechanical Engineers and of the American Institute of Electrical Engineers. His extensive experience in handling complicated manufacturing problems thoroughly equips him for his present duties.

Ralph E. Flanders was married on November 1 to Miss Helen Edith Hartness, a daughter of James Hartness, the president of the Jones & Lamson Machine Co. of Springfield, Vt. Mr. and Mrs. Flanders will continue to live in Springfield, where a house has been built for them, and Mr. Flanders will continue to give his attention to the work of the Fellows Gear Shaper Co. with which he is connected. Many of our readers will remember Mr. Flanders' work as Associate Editor of MACHINERY for a number of years, and especially those who are personally acquainted with him will join us in congratulations.

* * *

OBITUARIES

Francis B. Wilson, treasurer of the Jewell Belt Hook Co., Hartford, Conn., died at his home, 132 Jefferson St., after a long illness, on November 6, aged fifty-six years.

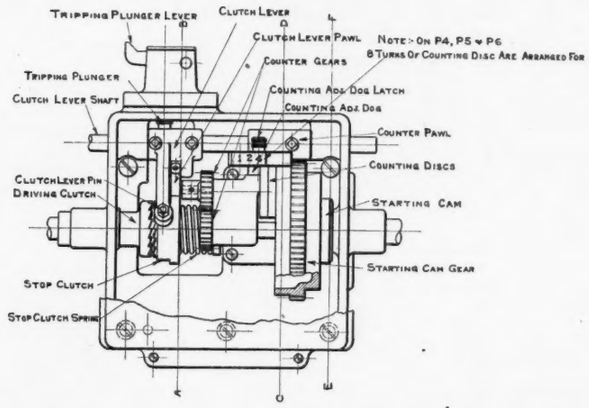
C. L. Rice, a pioneer in the mill supply business and one of the oldest members of the Dodge Mfg. Co.'s selling force, died as a result of a street accident in Chicago, Ill., November 3, aged eighty-nine years.

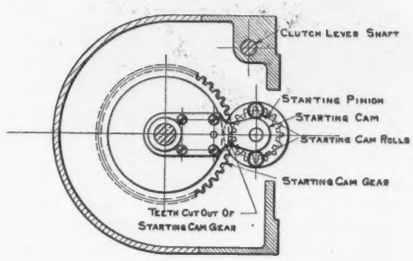
Thomas Fitzsimons, one of the original incorporators of the Novelty Mfg. Co., Waterbury, Conn., and for a number of years actively connected with it, died at his home, 83 Cherry St., Waterbury, Conn., November 5, aged seventy-three years.

T. F. Salter, manager of the sales and engineering departments of the Standard Roller Bearing Co., of Philadelphia, Pa., died very suddenly at his home in that city on Wednesday, October 25, at the age of thirty-five years. Mr. Salter was a member of the American Society of Mechanical Engineers and of the Society of Automobile Engineers.

5 DEC 1911

To cut accurate gears quickly, special features must be embodied in the indexing mechanism



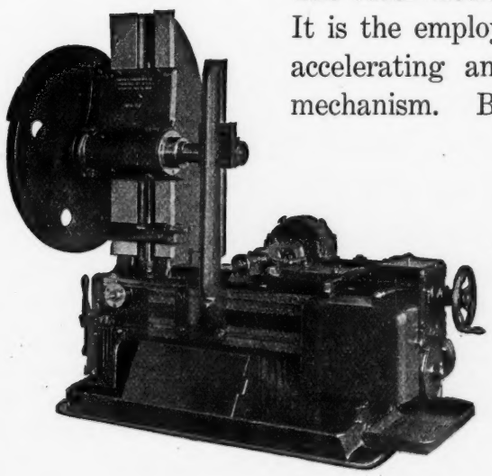


Section On E F

B & S AUTOMATIC GEAR CUTTING MACHINES

The accuracy of gears is almost sure to be impaired if they are cut on a machine the indexing mechanism of which operates with a shock.

Two methods can be used to prevent this. The first method is to run the index mechanism at a very slow rate of speed, thus securing accuracy at the sacrifice of time and at a great expense.



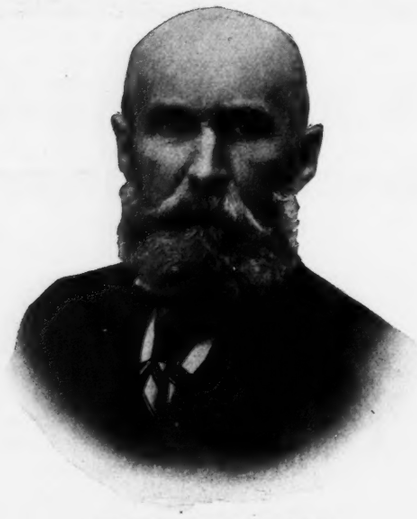
The other method is just as sure and more economical. It is the employment of a machine equipped with an accelerating and retarding motion of the indexing mechanism. By such means the indexing begins slowly, increases to a rapid rate, and then gradually comes to a stop. This does away with all shock, obviating inaccuracies due to this cause.

This is an exclusive B & S feature.

There are many other excellent features, all of which are explained in a circular, mailed on request.

BROWN & SHARPE MFG. CO.

PROVIDENCE, RHODE ISLAND, U. S. A.



RICHMOND VIALL

Richmond Viall, superintendent of the Brown & Sharpe Mfg. Co. since 1878, and one of the most widely known and highly esteemed men in the machinery industry, died at the Newport Hospital on November 9, from a paralytic stroke, in the seventy-seventh year of his age.

Mr. Viall was born in Barrington, R. I., December 16, 1834, and descended from one of the oldest New England families, which came to this country from England. Receiving his early schooling in East Providence, to which town his father had moved, he left at the age of seventeen to become a jeweler's apprentice. After remaining in the employ of Briggs, Hough & Stone for four years he went to Attleboro, Mass., in 1857, and worked at his trade until the Civil war broke out. Then for two years he engaged in the manufacture of cavalry sabres.

On January 6, 1863, Mr. Viall entered the employ of J. R. Brown & Sharpe as a screw machine operator, working for an average day's pay, and in a little less than a year he became foreman of the department, with thirty-seven men under him. In 1872, when the plant was moved to its present location, Mr. Viall assumed charge of the department devoted to the manufacture of the Willcox & Gibbs sewing machines, and six years later became superintendent of the works, a position which he held until his death. Although he retired from active work in 1902, he retained his interest in the company almost to the end. Taking hold of the superintendent's work in 1878, immediately after the panic, Mr. Viall found a world-wide demand for the company's product which was being supplied with a force reduced to less than 200 men on account of the financial depression. As the effects of the panic wore away the force of employes began to increase, and upon his retirement in 1902 more than 2000 men were on the pay-roll, and the floor space had increased to 360,000 square feet, or 8½ acres.

Many factors have contributed to the growth of the Brown & Sharpe Mfg. Co. One was the inventive genius of Joseph R. Brown, coupled with his high standard of workmanship, which has always been maintained; another was the far-sighted policy consistently adhered to by Lucian Sharpe, a man of unusual business ability; a third was Mr. Viall's personality. Not only was he qualified to superintend the practical operations of a large shop, but his democratic spirit, keen insight into human nature, and loyalty, all united to fit him in an unusual degree for the business he helped to expand. He was not a great mechanic in the ordinary sense, but he possessed executive ability and sterling integrity, and to these qualities must be attributed his remarkable and successful life.

In his work Mr. Viall fully realized the value of cooperation, and there was no more striking example of this than his willingness to work with his foremen and give each man credit for what he accomplished. He never allowed petty jealousies to disturb him or to arise among his men. He insisted upon honesty and dependableness among his foremen, and no man was chosen for this position unless he had these characteristics. It was Mr. Viall's opinion that the dissatisfaction and unsettled feelings which sometimes arise in the shop are caused in a great measure by unfair rivalry and by misunderstandings between the foremen and workmen. Accordingly he emphasized the law of mutual helpfulness, in the belief that cooperation increases the value of both skilled and unskilled workmen, and also tends to unify and harmonize shop life. Mr. Viall's reputation for giving careful directions as to the manner in which his instructions were to be carried out was such that there was never any doubt in the mind of the recipient as to the right course to follow.

No record of his life would be complete, however, without mention of his kind and sympathetic nature. He was always mindful of the welfare of his men and often visited them, searching out those whom he thought might need his help. It has been said that he was imposed upon many times, but he preferred to be imposed upon rather than injure anyone. And when he made a mistake and found that somebody had suffered through his error he sought out and apologized to the injured person. Mr. Viall's associates in business, those who knew him personally, and the thousands of men who have been at one time or another under his care, and who are to be found all over the world, will remember him with affection and admiration.

Mr. Viall was married in 1859 to Eliza M. Cole. Four children were born to them; one of them, William A. Viall, now being the secretary of the Brown & Sharpe Mfg. Co.

CHARLES H. PHILLIPS

Charles H. Phillips, well known to the machinery trade of the East, died on November 3 at his home in Providence, R. I., at an age of seventy-eight years. Up to two years ago, Mr. Phillips was in the employ of the Brown & Sharpe Mfg. Co., at which time he had been with this company more than forty years. For twenty-two years he represented the Brown & Sharpe Mfg. Co., as salesman in the Eastern territory.

Born in Taunton, Mass., in 1832, Mr. Phillips received a common school education and then became an apprentice at the Mason Machine Co., of Taunton. Here he obtained his fundamental training as a mechanic, and after eleven years, in 1856, he entered the employ of the firm of J. R. Brown & Sharpe, as the Brown & Sharpe Mfg. Co. was then known. After one and one-half year he became contract-foreman in the old Burnside Rifle Works, where he was very successful in manufacturing the old Burnside and Springfield rifles. After having been with this firm nine years, he again entered the employ of the Brown & Sharpe Mfg. Co., in 1867, as contract-foreman of the milling machine department. This position he held when he began to make trips representing the company twenty-four years ago. He was very successful as a salesman, and his success was due as much to his honesty in his dealings with his customers as to his loyalty to his firm. Outside of his work his chief interest was centered around his church, and he was actively engaged in that work almost up to the time of his death. He was also a member of the Odd Fellows. He is survived by four children, two sons and two daughters.

* * *

COMING EVENTS

December 5-8.—Annual meeting of the American Society of Mechanical Engineers in New York. Calvin W. Rice, secretary, 29 W. 39th St.

December 5-8.—Annual meeting of the National Gas and Gasoline Engine Trades Association at the Hotel Hollenden, Cleveland, Ohio. An exhibit of accessories will be an important feature of the convention. Albert Stritmatter, secretary, 224 E. Seventh St., Cincinnati, Ohio.

January 6-13.—Passenger automobile exhibition, Madison Square Garden, New York.

January 10-17.—Combined passenger and commercial car exhibition, Grand Central Palace, New York.

January 15-20.—Commercial vehicle exhibition, Madison Square Garden, New York.

January 18-20.—Annual meeting of the Society of Automobile Engineers in New York. Coker F. Clarkson, general manager, 1451 Broadway, New York.

January 27-February 3.—Passenger automobile exhibition, Coliseum and First Regiment Armory, Chicago, Ill.

February 5-10.—Commercial vehicle exhibition, Coliseum and First Regiment Armory, Chicago, Ill.

May 14-17.—Sixth annual convention of the Master Boiler Makers' Association at the Fort Pitt Hotel, Pittsburg, Pa.

June 12-14.—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J.

June 17-19.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J.

September 2-7.—Sixth congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. One of the important functions of this association is to establish standard specifications for materials used in manufacture and construction. The cooperation of engineers and others who are engaged in the purchase and use of the raw materials of the trades, is requested. The annual dues are $2, with no initiation fee. Mr. H. F. J. Porter, secretary, 1 Madison Ave., New York.

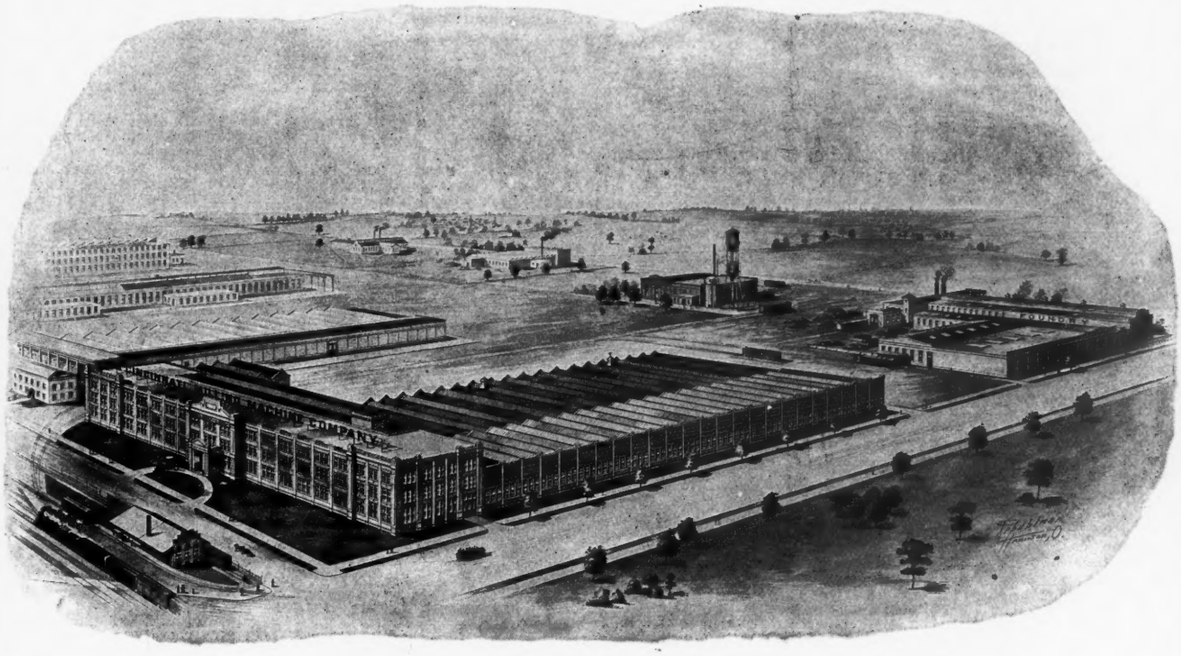
SOCIETIES AND COLLEGES

MARYLAND AGRICULTURAL COLLEGE, College Park, Md. Catalogue 1911-1912, giving a complete review of the college courses, entrance requirements, expenses, etc.

SOCIETY OF RAILWAY CLUB SECRETARIES, 95 Liberty St., New York. Index of papers and subjects discussed by railway clubs from May 31, 1910, to May 31, 1911.

University of Iowa
5
LIBRARY

COME AND SEE US IN OUR NEW PLANT



THE PLANT DRAWN TO AN EXACT SCALE

OUR new plant is only 40 minutes from the hotel district. It contains 275,000 square feet of floor space exclusive of power house, which makes it the largest milling machine manufacturing plant in the world. The buildings have been planned for the most efficient handling and routing of materials, and provide ideal factory conditions as to lighting, heating and ventilation. Our equipment has been especially selected and tooled up for manufacturing in large quantities. Many important parts are made on machines designed especially for individual operations.

These things are not possible in the shop producing a smaller volume. They enable us to produce very much better machines and give you bigger value for the price.

We devote all our time and energy to the design and manufacture of Milling Machines and Milling Cutter Grinders. By this specialization and this concentration of effort on the part of a corps of men especially trained in this line of work, we are able to produce machines of the highest quality as to design, materials and workmanship.

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI, OHIO, U. S. A.

AMERICAN MUSEUM OF SAFETY, 29 W. 39th St., New York. Safety leaflet No. 2 on foundry safeguards, showing some safety devices for preventing accidents to the molder.

AMERICAN BRASS FOUNDERS' ASSOCIATION. Bulletin No. 10, containing list of new members elected, review of important articles in the engineering press, and a review of patents of interest to brass founders.

UNIVERSITY OF NEW MEXICO, Albuquerque, N. M. Bulletin No. 61 entitled "How the Curriculum of the Secondary School Might Be Reconstructed." The bulletin contains 25 pages, 5¼ by 7½ inches, and includes considerable matter of interest to those engaged in educational work.

NEW BOOKS AND PAMPHLETS

ELECTRICAL ACCIDENTS IN MINES, THEIR CAUSES AND PREVENTION. Miners' Circular No. 5. 10 pages, 6 by 9 inches. Published by the Department of the Interior, Washington, D. C.

FARMING POSSIBILITIES OF THE DELAWARE, MARYLAND AND VIRGINIA PENINSULA. 52 pages, 5½ by 7¾ inches. Illustrated with halftones. Published by the Pennsylvania Railroad, Philadelphia, Pa.

PENNSYLVANIA RAILROAD AT THE AMERICAN LAND AND IRRIGATION EXPOSITION IN NEW YORK, NOVEMBER 3-12, 1911. 38 pages, 4¼ by 6¾ inches. Published by the Pennsylvania Railroad, Philadelphia, Pa.

ANNUAL REPORT OF THE CHIEF OF BUREAU OF MANUFACTURES TO THE SECRETARY OF COMMERCE AND LABOR FOR THE FISCAL YEAR ENDED JUNE 30, 1911. 16 pages, 6 by 9 inches. Published by the Department of Commerce and Labor, Washington, D. C.

CONSTRUCTIVE RAILWAY POLICIES. 30 pages, 6½ by 9½ inches. Published by the Railway Business Association, 2 Rector St., New York.

This pamphlet is bulletin No. 9 of the Railway Business Association and reviews the constructive railway policy of several of the states of the Union in 1911.

ALCOHOLISM IN INDUSTRY. By Wm. H. Tolman. 40 pages, 4½ by 7 inches. Published by the American Museum of Safety, New York. Price, 10 cents.

This is one of a series of manuals of safety published in the interest of the prevention of accidents. The present booklet deals with some European methods of preventing such accidents as are due to the use of alcoholic beverages by industrial workers.

MECHANICAL WORLD POCKET DIARY AND YEAR BOOK FOR 1912. 330 pages, 4 by 6 inches. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Price 6d.

This is the 25th edition of the *Mechanical World's* popular handbook, containing the usual information arranged in convenient form for ready reference. A number of new features have been introduced. The section on steam turbines has been partly rearranged and considerably extended, and information is also included on indexing on milling machines; verniers and micrometers; roller bearings; helical springs; cutters for milling spiral gears; speed calculations, etc. The number of illustrations has been increased.

THE COPPER HAND-BOOK. By Horace J. Stevens. 1902 pages, 6 by 9 inches. Published by the author, Houghton, Mich. Price, $5.00.

This book is the tenth annual edition of a hand-book which is considered a standard authority on the subject of copper and copper mines. It covers all the countries in the world and lists and describes over 8000 copper mines and copper mining companies. In addition there are twenty-four miscellaneous chapters treating on copper from different viewpoints, there being chapters on the history, geology, chemistry, mineralogy, metallurgy, brands and grades, and alloys of copper. A chapter of statistics containing about forty tables covering copper production, prices, dividends, etc., is included. The book is sent by mail prepaid to any address without advance payment, and subject to return after a week's inspection.

WOOD-TURNING, WOODWORKING MACHINES AND PATTERNMAKING. By George H. Resides and Hugo Diemer. 117 pages, 10½ by 7¾ inches. 169 illustrations. Published by the McGraw-Hill Book Co., New York. Price, $1.50.

This book is intended as a text-book for university, college and technical high school shops, and for apprenticeship courses. The aim of the book is to present principles, descriptive matter and exercises, so as to develop the students' ability in woodworking, and in its application in the manufacturing industries and in patternmaking. Chapters are contained on the wood lathe and its equipment, methods for sharpening tools are shown and described, and a number of exercises for producing special objects are given. The book reviews the ordinary woodworking machines found in the regular pattern shop, and deals specifically with patternmaking and subjects relating to this trade.

BEARINGS AND THEIR LUBRICATION. By L. P. Alford. 235 pages, 6 by 9 inches. 131 illustrations. Published by the McGraw-Hill Book Co., New York. Price, $2.50.

In the preface of this book the author states that the reason for its publication has been to present the underlying principles involved in the design of all classes of machine bearings, and to show modern practice in the construction and application of important commercial types. The book contains a great deal of data useful to the designing engineer. Many of these data have never before been published, and many of the experiments and researches quoted are from European sources not generally available to American readers. The treatment is divided into two parts, one dealing with bearings with sliding contact, and one with bearings with rolling contact. The data given for coefficient of friction of journal, collar, step and guide bearings are very complete, and will be found the more useful as these data are often difficult to obtain.

THERMODYNAMICS OF THE STEAM TURBINE. By Cecil H. Peabody. 282 pages, 6 by 9 inches. 103 illustrations. Published by John Wiley & Sons, New York. Price, $3.00.

The author of this book is professor of naval architecture and marine engineering at the Massachusetts Institute of Technology, and the book contains a systematic treatment of the thermodynamics of the steam turbine, especially prepared for students in technical schools. Constructive details are considered as far as they are necessary for a proper understanding of thermodynamic computations. The methods explained are in general those accepted by steam-turbine designers, although certain methods have been devised by the author in such cases where new methods would lead more rapidly or precisely to the desired end. The chapters of the book are headed as follows: Introduction; Steam-Nozzles; Jets and Vanes; Simple Impulse Turbines; Pressure Compounding; Velocity Compounding; Pressure and Velocity Compounding; Reaction Turbines; Accessories; Effect of Conditions; Marine Steam Turbines.

MAXIMUM PRODUCTION IN MACHINE SHOP AND FOUNDRY. By C. E. Knoeppel. 365 pages, 5 by 7½ inches. Published by the *Engineering Magazine*, New York. Price, $2.50.

This book is based on three series of articles originally published in the *Engineering Magazine*. The machine shop and factory are considered so closely related that the problems concerning the two are assumed to be best studied together. The information is based upon the author's personal experience. The foundry, particularly, is given close attention, because in the past it has been noted for less systematic methods and it still offers great possibilities for improvement in management and methods. The chapters of the book are headed as follows: The Two Great Forces in Manufacturing; Importance of Efficient Organization; The Elements of Accounting and Management; Maintenance, New Construction and Reconstruction; Systematic Processing, Assembly, and Erection; Efficiency in the Use of Materials and Time; Better Deliveries—More Satisfied Customers; Scientific Management in the Foundry; Foundry Organization and Management; Foundry Production and Its Details; Efficient Despatching in the Foundry; Handling Shop Details; Importance of Correct Burden Apportionment; Elements of Foundry Production Costs; Apportionment of Foundry Costs to Production; Cost Apportionment in Various Classes of Foundries.

CATALOGUES AND CIRCULARS

GENERAL ELECTRIC CO., Schenectady, N. Y. Leaflet describing electric glue pots.

AMERICAN OXHYDRIC CO., Milwaukee, Wis. No. 5 of the leaflets entitled "Oxhydric Sparks."

STRONG, CARLISLE & HAMMOND CO., Cleveland, Ohio. Circular of Frankfort furnaces, showing three types and giving general dimensions.

DUFF MFG. CO., Pittsburg, Pa. Folder illustrating the constructional features of Duff-Bethlehem hydraulic jacks, and comparing this design with designs of other types.

AMERICAN-SWISS FILE & TOOL CO., 24 John St., New York. Booklet entitled "The Lady from Paterson—A True Story." The little story teaches the lesson that home products may be as good as or superior to those imported.

CHALLENGE MACHINE CO., INC., 5116 Springfield Ave., Philadelphia, Pa. Folder illustrating and describing Challenge grinders. A number of different types are illustrated and general specifications are given, together with price list.

ERIE FORGE CO., Erie, Pa. Photograph of the company's open-hearth furnace in operation, giving an idea of the facilities this company has for manufacturing carbon and alloy—such as nickel and chrome-vanadium—steel.

H. W. JOHNS-MANVILLE CO., 100 William St., New York. Booklet entitled "The Roof Everlasting," describing the asbestos fire-proof shingles manufactured by the company. Complete data of size, weight, cost, etc., and method of application, are included.

BRISTOL CO., Waterbury, Conn. Folder showing Bristol recording thermometers, voltmeters, wattmeters, electric time recorders, electric pyrometers and differential pressure gages. Brief references to the general use of the various instruments are included.

MORSE CHAIN CO., Ithaca, N. Y. Pamphlet entitled "A Modern Power Transmitter," describing the Morse silent-running high-speed chains and showing installations where this chain is employed. An interesting comparison between rope drive and chain drive is included.

INGERSOLL-RAND CO., 11 Broadway, New York. Bulletin No. 4003 on "Little Giant" rock drills. The bulletin contains a table of this type of drill, giving the principal dimensions. A sectional view of the machine is shown, and also illustrations of several machines at work on the Panama Canal.

CHARLES A. STICKNEY CO., St. Paul, Minn. Circular describing Stickney worm-gear pump jacks. One feature of these is that the frame of the jack encases the gears so that the operator is protected from injury, and, in addition, an oil receptacle is formed which thoroughly lubricates the gearing.

WALWORTH MFG. CO., Boston, Mass. Circular descriptive of the advantages of the genuine Stillson wrench which has been manufactured by the company for over forty years. These wrenches are made in sizes from 6 inches to 18 inches with wood handles, and from 10 inches to 48 inches with steel handles.

KERR TURBINE CO., Wellsville, N. Y. Bulletin No. 20, dealing with the improvements made in Kerr turbo-blowers and turbo-pumps, especially intended for gas plant service. Bulletin No. 22, describing and illustrating installations of turbo-generator sets for lighting, with special reference to independent lighting plants.

FITCHBURG MACHINE WORKS, Fitchburg, Mass. Circular entitled "The Lo-swing Lathe" describing the general details of the lathe and showing work produced on same. The description is profusely illustrated with halftones and line engravings and gives a comprehensive idea of the design and capacity of the Lo-swing lathe.

VULCAN CRUCIBLE STEEL CO., Aliquippa, Pa. Booklet giving information about the company's products in vanadium steels, referring to the forging and heat treatment of alloy steels, in general, and when used for casehardened products and for gears and tools. Directions are also given for heat treating Wolfram high-speed steel and Vulcan special vanadium steel.

PETERSON ENGINEERING CO., Hudson Terminal Bldg., New York. Bulletin No. 56 on Economy elevator guide lubricators describes a new method of lubricating elevator guides. The method consists in applying a thin layer of grease exactly where the shoes bear on the rails. The grease is applied for every trip of the car. Different types of lubricators suitable for steel and wooden rails are described.

REYNOLDS PATTERN & MACHINE CO., 101-103 Third Ave., Moline, Ill. Circular describing the improved Reynolds automatic screw-driver with magazine feed for wood or machine screws. These screw-driving machines are built in several different types, including four standard types, one radial and one gap column type, and also a type with an auxiliary drill spindle. The machines are fitted with tight and loose pulleys for belt drive.

WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburg, Pa. Leaflet No. 2373 describing No. 303–A box frame interpole motor manufactured by the company. Particular stress is laid upon the fact that the motor is equipped with axle-bearing dust guards, which greatly prolong the life of the bearings and gears. Leaflet No. 2374 gives specifications and brief descriptions of the parts of the company's railway motor No. 310–C.

AMERICAN BLOWER CO., Detroit, Mich. Hand-book of information on blowers and exhausters for forges and furnaces. The little hand-book, comprising 24 pages, is intended to enable prospective purchasers to select the proper size and type of blower or exhaust fan for their requirements. The information covers blowers for ordinary blacksmith forges, for heating furnaces, for plates and rivets, and for melting furnaces, as well as exhaust fans for removing smoke, gases, fumes, etc.

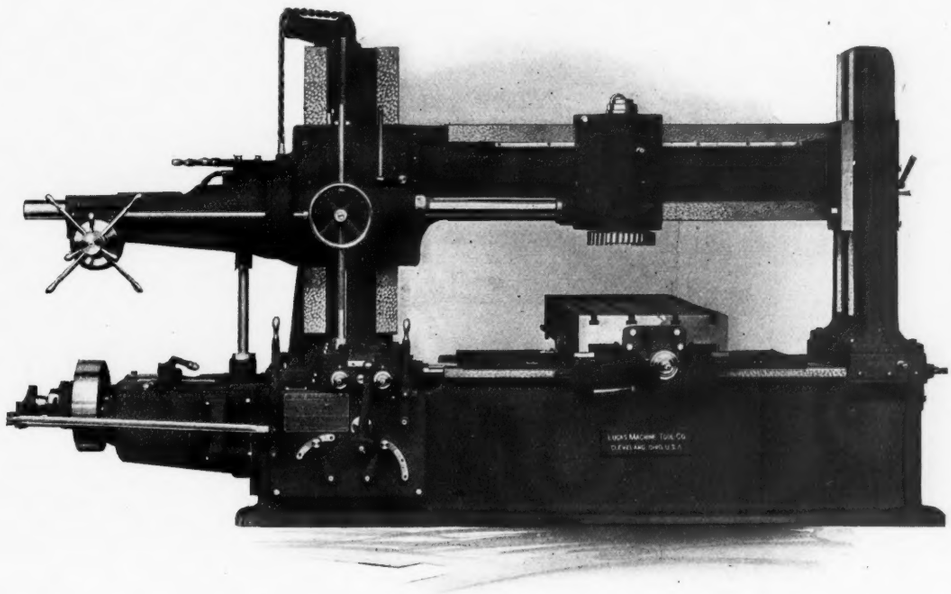
NORMAN W. HENLEY & SON, 132 Nassau St., New York. Circular advertising pads of paper ruled at certain angles adaptable for drawing objects in isometric perspective or projection. By using paper ruled in this manner drawings in isometric projection can easily be made by anyone who has even elementary understanding of the principles involved. The paper is sold in pads of 40 sheets, 6 by 9 inches and 9 by 12 inches. It is also sold in loose sheets, 12 by 18 inches.

TATE, JONES & CO., INC., Empire Bldg., Pittsburg, Pa. Catalogue of furnaces for heating, forging and welding. The subject of furnace

Can you imagine any job of boring, drilling or milling that cannot be done on this machine?

THE No. 32 "PRECISION" BORING, DRILLING and MILLING MACHINE

with VERTICAL MILLING ATTACHMENT



Power feeds with quick returns in **every** direction. Same number of feeds and same amount of feed wherever applied. Interlocking feed system; impossible to get in more than one feed at the same time, or to get in any feed not wanted.

ALL feeds **started** and **returned** by quick power **motion** by ONE lever.

Lucas Machine Tool Co., NOW AND ALWAYS OF **Cleveland, O., U.S.A.**

AGENTS—C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao, Barcelona. Schuchardt & Schutte, Berlin, Stockholm, St. Petersburg, Copenhagen. Donauwerk Ernst Krause & Co., Vienna and Budapest. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal.

efficiency is dealt with, and various types of tool dressing furnaces, blacksmith forges, rivet forges, pipe bending furnaces, bolt heading furnaces, flue welding furnaces, rod heating furnaces, and forging furnaces of various sizes, are illustrated and described. Line engravings are used in many cases to show the actual construction of the furnaces.

SLATER, MARSDEN & WHITTEMORE CO., Beloit, Wis. Catalogue No. 7 on punches, shears, bending rolls, and woodworking machinery. A line of combined power punches and shears is illustrated and specifications given. The catalogue also shows and describes the company's make of alligator shears, back-geared power splitting shears, boilermakers' lever punches, lever splitting shears, hand bench punches, lever punches and lever shears, swing cut-off saws, combination rip and cut-off saws, and bending rolls.

INGERSOLL-RAND CO., 11 Broadway, New York. Catalogue describing "Imperial Type X" duplex steam-driven compressors, showing several views of the machine and its details, and containing tables of standard sizes and capacities. The air cylinders have water-jacketed barrels and heads, the latter being hooded for the admission of clean air. The smaller compressors, up to 16-inch stroke, have overhung cylinders, but on the larger sizes the air cylinders are supported on a foot-piece resting upon a sole-plate on the foundation.

SHEPARD ELECTRIC CRANE & HOIST CO., Montour Falls, N. Y. Bulletin No. 504 illustrating and describing Shepard monorail traveling hoists designed for the economical handling of any material used for manufacturing. The hoist may be used in connection with grab buckets, lifting magnets, cars, slings, etc. One lumber yard reports that the reduction in the cost of handling lumber and other wood products is 41 per cent, and another lumber company reduced the cost of handling 1000 feet of lumber from $1.20 to $0.12 by the use of these electric traveling hoists.

CINCINNATI ELECTRICAL TOOL CO., 650-652 Evans St., Cincinnati, O. Catalogue of "Peerless" portable electric drills, reamers and grinders. The complete line of these tools, as manufactured by the company, is illustrated and described, and important dimensions are tabulated. The catalogue covers fifty-two 6 by 9 pages, and includes portable electric drills of various types and sizes, portable reamers, Scotch radial drills, portable toolpost grinders, portable bench grinders, floor grinders with one and two wheels, internal grinders, portable aerial grinders and buffers, and portable electric blowers. All the tools described are air-cooled.

C. H. CATON & CO., LTD., Keighley, England. Loose leaf catalogue illustrating the line of machine tools manufactured by the company, including horizontal boring machines, radial drilling and tapping machines, plain milling machines, combined milling and slotting machines for locomotive cylinders, heavy duty slotting machines, double-head slotting machines, rack driven planers, special drilling and tapping machines for locomotive wheels, combined multiple radial drilling and milling machines, cylinder boring and facing machines, vertical turning and boring mills, and engine lathes. The machines are well illustrated; a general description is given, and the most important dimensions included.

NATIONAL TWIST DRILL & TOOL CO., Detroit, Mich. Catalogue No. 7 of twist drills, reamers, milling cutters and special tools. The catalogue contains 160 pages, 5 by 7½ inches, and gives general dimensions and price list of the large line of different types of tools manufactured by the company, comprising twist drills, straight-fluted drills, special drills, machine bits for wood, oil-tube drills, hollow drills, center drills, countersinks, sockets and sleeves, drill chucks, mandrels, reamers of all types, solid and built-up counterbores, solid and inserted blade milling cutters, end-mills, and special cutters. A number of useful tables are also included, and the catalogue is conveniently arranged for reference.

BROWN & SHARPE MFG. CO., Providence, R. I. Series of six booklets on grinding and grinding machines, containing many practical points that are of interest to foremen and workmen employed in grinding rooms. The titles of the various booklets give an idea of their contents. They are as follows: "In the Shops where B. & S. Grinding Machines are Built;" "Rigid Machine Tool Construction—Its Value in Grinding Machines;" "Accurate Grinding is Largely Due to Alignments of Machine;" "Features that adapt B. & S. Machines to Commercial Grinding;" "Points About Grinding Wheels and Their Selection;" "Why Independent Speeds and Feeds are Essential in Grinding Machines." The booklets are well illustrated with halftones and line engravings.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4860, giving a brief outline of the fundamental principles of electro-metallurgy and its principal applications. The bulletin is intended to aid prospective buyers in the selection of proper apparatus for work of this character. Bulletin No. 4883, describing the construction of Curtis steam turbine generators. This bulletin contains a detailed description of the steam turbine parts, and shows installations of steam turbine generator sets. Bulletin No. 4885, describing Thomson watt-hour meters, designed for accurately measuring the power used by relatively small consumers. Bulletin No. 4886, devoted to the advantages of electric power in coal mine operation. Bulletin No. 4889, describing commutator grooving machines. Bulletin No. 4891, showing a series of illustrations of electric railway equipment. Bulletin No. 4894, describing cylinder controllers for railway service.

TRADE NOTES

STEINLE TURRET MACHINE CO., Madison, Wis., is building an addition for an office and tool-room.

KELLER MECHANICAL ENGRAVING CO., has removed its factory to the Gair Bldg., 70 Washington St., Brooklyn, N. Y.

FOOTE BROS. GEAR & MACHINE CO., Chicago, Ill, manufacturer of iron, steel and rawhide cut gears has made a large addition to its shop. The new building will double the capacity.

TOLEDO BRIDGE & CRANE CO., Toledo, Ohio, has made arrangements with A. W. Wyckoff & Co., 2219 Farmers Bank Bldg., Pittsburg, Pa., to represent the company in the sale of cranes in the Pittsburg district.

BERGER MFG. CO., Canton, Ohio, recently installed a steel rack storage system for patterns at the Johnston Harvester Co., Batavia, N. Y. The installation consists of 72 units, each 5 feet wide, 11 feet 6 inches high.

A. EUGENE MICHEL, advertising engineer, on account of constantly increasing business, has removed his offices to the Park Row Bldg., 21 Park Row, New York, and all business will be managed from the new office in the future.

CINCINNATI LATHE & TOOL CO., Cincinnati, Ohio, has removed from its former plant at Spring Grove Ave., to its new shop at Oakley, Ohio, a suburb of Cincinnati. The new shop is modern in every way, and the company is now equipped to handle its rapidly increasing lathe manufacturing business.

DODGE MFG. CO., Mishawaka, Ind., had an exhibit at the exposition in Boston which was held during the latter part of October under the auspices of the Boston Chamber of Commerce. The most prominent items exhibited were solid and split clutches, iron-center wood-rim pulleys, keyless and Collins couplings, etc.

CINCINNATI BICKFORD TOOL CO., Oakley, Cincinnati, Ohio, exhibited three Cincinnati upright drilling and tapping machines and one Cincinnati Bickford radial drill at the exposition held this summer at Turin, Italy. Information has just been received to the effect that the jury awarded the company the "grand prix" for its exhibit.

J. H. WILLIAMS & CO., 61 Richards St., Brooklyn, N. Y., are reported to have bought sixty-one acres of ground near Buffalo, and will move their business to that city. A $1,000,000 plant will be built, and drop-forging products will be manufactured as soon as the plant is finished. It is expected that about 1000 men will be employed.

LUCAS MACHINE TOOL CO., 99th St. and L. S. & M. S. Ry., Cleveland, Ohio, maker of the Lucas horizontal boring machine, is building a 40 by 170-foot addition. The addition is a 40-foot extension of the sawtooth roof sections of the plant, in harmony with the general plan, and enlarges each department by the same amount of floor space.

ROTH BROS. & CO., Chicago, Ill., have recently shipped to the Wagner Mfg. Co., Sidney, Ohio, manufacturer of aluminum ware, ten five-horsepower polishing motors of a new, improved, ventilated type which they have recently placed on the market. All ten machines will be used for polishing the aluminum utensils manufactured by the Wagner Mfg. Co.

ADAMS-BAGNALL ELECTRIC CO., Stantan Ave. and C. & P. Ry., Cleveland, Ohio, is erecting a six-story steel and concrete construction building, containing 100,000 square feet of floor space, to provide for the needs of its rapidly growing business. The company makes electric lamps for street and factory lighting, electric ventilating fans, etc.

AMERICAN SHIP WINDLASS CO., builder of the Taylor stoker and marine equipment, which has for over half a century been located at Providence, R. I., has removed all its business to Philadelphia, Pa., where the company already had a large plant. To accommodate the growing business, a large foundry has recently been erected in the latter city.

H. W. JOHNS-MANVILLE CO., 100 William St., New York, due to the increase of business, has changed the location of its Birmingham, Ala., office from 1220 Empire Bldg. to 606 Chamber of Commerce Bldg. The office will continue under the management of W. H. Fleming. A complete line of the company's products will be handled from the Birmingham office.

MATTHEWS-DAVIS TOOL CO., 219 N. Second St., St. Louis, Mo., manufacturer of Davis expansion boring tools, has just moved into a new plant, the new structure consisting of three stories, having a total floor space of 15,750 square feet. The plant is equipped with the most modern machine tools, and the hardening-room is provided with cyanide, gas and coke furnaces.

WESTINGHOUSE ELECTRIC & MFG. CO., East Pittsburg, Pa., recently received a contract for additional electrical equipment for the central power plant of the Mare Island Navy Yard, California. The equipment includes six induction motors, three transformers, two 25-kilowatt turbo-generator exciter sets; one 20-kilowatt motor-driven exciter set, and one 19-panel station switchboard.

INTERNATIONAL ACHESON GRAPHITE CO., Niagara Falls, N. Y., has been awarded a grand prize at the Turin Exposition for the company's exhibit of its products. This company has previously been given the highest awards at other world's expositions where its products have been exhibited, and the last award at the Turin Exposition is thus additional testimony of the quality of its products.

BEST MFG. CO., Pittsburg, Pa., has appointed Mr. Charles E. Hague its representative in Philadelphia, Pa., with headquarters at 1510 Land Title Bldg. The Philadelphia office will have charge of Eastern Pennsylvania, and the Baltimore and Washington territory. The company has also appointed C. L. Stickney & Co. as its representatives in the states of Washington and Oregon, the headquarters being at 108 White Bldg., Seattle, Wash.

H. V. LEWIS CO., 30 Church St., New York, has been formed for the purpose of representing a few well-known manufacturers of machine tools in the New York and Philadelphia territory. The officers of the company are: H. V. Lewis, president; George C. Hughes, vice-president; and Arthur H. Valiquette, secretary and treasurer. Mr. Lewis and Mr. Valiquette will be actively engaged in the conduct of the business from this time forth.

NEW DEPARTURE MFG. CO., Bristol, Conn., has installed at its Western branch, 1016 Ford Bldg., Detroit, Mich., a measuring machine which is available to the trade in general for close measuring. The use of the machine is offered without cost. The machine positively indicates variations of 1/40 of 0.001 inch, and is a duplicate of the machine used by the company in accurately manufacturing gages for inspecting New Departure ball bearings.

AMERICAN BLOWER CO., Detroit, Mich., has purchased a four and one-half acre plot in Windsor, Ontario, Canada, for the erection of a plant for the Canadian branch. Application has been made for a charter of incorporation under the name of Canadian Sirocco Co., Ltd. The plant will be completely equipped for building blowers, and heating and ventilating apparatus. The erecting shop, 50 by 200 feet, and office building, will be built immediately, and a foundry, steel plate fan shop, and heating apparatus shop, will be built in the spring.

DAVIS-BOURNONVILLE CO., 97 West St., New York, announces that the company has been appointed exclusive selling agent for the welding and cutting apparatus made by Davis-Bournonville Acetylene Development Co., and the National Pneumatic Co. The business of the Davis-Bournonville Co. will be divided into the Eastern department with offices at 97 West St., New York, and the Western department with offices at 515 Laflin St., Chicago, Ill., where at present the Chicago welding department of the National Pneumatic Co. has its quarters.

ROCKFORD DROP FORGE CO., Rockford, Ill., is erecting a reinforced concrete building, 65 by 100 feet, for a drop-forge plant. The building will be 30 feet high in the clear, and will have a monitor roof. It has been designed in accordance with modern ideas as to lighting and ventilation. Windows filling practically the entire side walls are fitted with Fenestra steel sash. The boiler house, engine room, and coal storage building form a wing, 40 by 75 feet. The plot on which the building stands affords room for extensions. Mr. Gustave Falleen is the general manager.

MICHIGAN ELECTRIC WELDING CO., Third and Congress Sts., Detroit, Mich., has acquired the business of the Detroit Welding Co., and will consolidate the two concerns under the name of Michigan Electric Welding Co. The consolidated concern will have an electric welding equipment capable of handling almost any kind of product, but will specialize on automobile work. The development of electric welding in Detroit is second only to that of Cleveland, the first city in the United States in electric welding. The consolidated concern will also be equipped to do autogenous welding.

PATTERSON TOOL & SUPPLY CO., Dayton, O., of which Mr. W. B. Patterson is president, is endeavoring to interest dealers in machinery in the organization of a "clearing house" for machine tools. Mr. Patterson's idea is that when a dealer gets an inquiry for a machine tool which he has not in stock, he can through the medium of one letter to the clearing house, or a telegram, or a long-distance telephone call, get such information as he may require, instead of having to write to a large number of dealers, or look over advertisements to try to find what he wants. Some dealers have signified

Copyright 1911, by The Industrial Press, New York

MILLING RADIAL TEETH IN CUTTER BLANKS—V

Angle of Milling Cutter in Degrees	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head
50	30	0.0150	0.1655	79° 44′
		0.0200	0.1613	
		0.0250	0.1570	
		0.0300	0.1526	
		0.0350	0.1484	
	32	0.0150	0.1540	80° 24′
		0.0200	0.1498	
		0.0250	0.1455	
		0.0300	0.1418	
		0.0350	0.1370	
	34	0.0150	0.1440	80° 59′
		0.0200	0.1397	
		0.0250	0.1354	
		0.0300	0.1311	
		0.0350	0.1269	
55	30	0.0150	0.1380	81° 27′
		0.0200	0.1345	
		0.0250	0.1309	
		0.0300	0.1274	
		0.0350	0.1238	
	32	0.0150	0.1285	82° 0′
		0.0200	0.1249	
		0.0250	0.1214	
		0.0300	0.1179	
		0.0350	0.1142	
	34	0.0150	0.1200	82° 29′
		0.0200	0.1165	
		0.0250	0.1130	
		0.0300	0.1094	
		0.0350	0.1058	
60	30	0.0150	0.1140	82° 57′
		0.0200	0.1110	
		0.0250	0.1080	
		0.0300	0.1050	
		0.0350	0.1021	
	32	0.0150	0.1060	83° 24′
		0.0200	0.1036	
		0.0250	0.1012	
		0.0300	0.0977	
		0.0350	0.0943	
	34	0.0150	0.0992	83° 48′
		0.0200	0.0963	
		0.0250	0.0933	
		0.0300	0.0903	
		0.0350	0.0874	
65	30	0.0150	0.0920	84° 19′
		0.0200	0.0896	
		0.0250	0.0872	
		0.0300	0.0848	
		0.0350	0.0824	
	32	0.0150	0.0856	84° 41′
		0.0200	0.0833	
		0.0250	0.0808	
		0.0300	0.0785	
		0.0350	0.0761	
	34	0.0150	0.0801	86° 0′
		0.0200	0.0777	
		0.0250	0.0753	
		0.0300	0.0729	
		0.0350	0.0706	
70	30	0.0150	0.0718	85° 34′
		0.0200	0.0700	
		0.0250	0.0681	
		0.0300	0.0662	
		0.0350	0.0643	
	32	0.0150	0.0668	85° 51′
		0.0200	0.0650	
		0.0250	0.0631	
		0.0300	0.0612	
		0.0350	0.0594	
	34	0.0150	0.0625	86° 6′
		0.0200	0.0607	
		0.0250	0.0588	
		0.0300	0.0569	
		0.0350	0.0551	
75	30	0.0150	0.0529	86° 44′
		0.0200	0.0515	
		0.0250	0.0501	
		0.0300	0.0487	
		0.0350	0.0474	
	32	0.0150	0.0492	86° 57′
		0.0200	0.0479	
		0.0250	0.0465	
		0.0300	0.0451	
		0.0350	0.0437	
	34	0.0150	0.0460	87° 8′
		0.0200	0.0447	
		0.0250	0.0433	
		0.0300	0.0419	
		0.0350	0.0405	
80	30	0.0150	0.0348	87° 51′
		0.0200	0.0339	
		0.0250	0.0330	
		0.0300	0.0321	
		0.0350	0.0312	
	32	0.0150	0.0324	87° 59′
		0.0200	0.0315	
		0.0250	0.0306	
		0.0300	0.0297	
		0.0350	0.0288	
	34	0.0150	0.0303	88° 7′
		0.0200	0.0294	
		0.0250	0.0285	
		0.0300	0.0276	
		0.0350	0.0267	
85	30	0.0150	0.0173	88° 56′
		0.0200	0.0168	
		0.0250	0.0164	
		0.0300	0.0160	
		0.0350	0.0155	
	32	0.0150	0.0161	89° 0′
		0.0200	0.0157	
		0.0250	0.0153	
		0.0300	0.0148	
		0.0350	0.0148	
	34	0.0150	0.0150	89° 4′
		0.0200	0.0146	
		0.0250	0.0141	
		0.0300	0.0136	
		0.0350	0.0132	

Contributed by George W. Burley

No. 149, Data Sheet, MACHINERY, December, 1911

MILLING RADIAL TEETH IN CUTTER BLANKS—VI

Angle of Milling Cutter in Degrees	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head
50	36	0.0150	0.1352	81° 30′
		0.0200	0.1309	
		0.0250	0.1266	
		0.0300	0.1224	
		0.0350	0.1181	
	38	0.0150	0.1272	81° 57′
		0.0200	0.1229	
		0.0250	0.1187	
		0.0300	0.1144	
		0.0350	0.1102	
	40	0.0150	0.1201	82° 23′
		0.0200	0.1160	
		0.0250	0.1117	
		0.0300	0.1074	
		0.0350	0.1033	
55	36	0.0150	0.1127	83° 55′
		0.0200	0.1091	
		0.0250	0.1056	
		0.0300	0.1021	
		0.0350	0.0985	
	38	0.0150	0.1061	83° 18′
		0.0200	0.1025	
		0.0250	0.0990	
		0.0300	0.0954	
		0.0350	0.0919	
	40	0.0150	0.1002	83° 38′
		0.0200	0.0967	
		0.0250	0.0932	
		0.0300	0.0896	
		0.0350	0.0861	
60	36	0.0150	0.0930	84° 9′
		0.0200	0.0900	
		0.0250	0.0871	
		0.0300	0.0833	
		0.0350	0.0812	
	38	0.0150	0.0876	84° 29′
		0.0200	0.0847	
		0.0250	0.0818	
		0.0300	0.0789	
		0.0350	0.0759	
	40	0.0150	0.0827	84° 45′
		0.0200	0.0798	
		0.0250	0.0769	
		0.0300	0.0739	
		0.0350	0.0710	
65	36	0.0150	0.0751	85° 18′
		0.0200	0.0728	
		0.0250	0.0704	
		0.0300	0.0680	
		0.0350	0.0656	
	38	0.0150	0.0707	85° 38′
		0.0200	0.0688	
		0.0250	0.0660	
		0.0300	0.0637	
		0.0350	0.0613	
	40	0.0150	0.0668	85° 46′
		0.0200	0.0645	
		0.0250	0.0621	
		0.0300	0.0597	
		0.0350	0.0574	
70	36	0.0150	0.0586	86° 19′
		0.0200	0.0568	
		0.0250	0.0549	
		0.0300	0.0531	
		0.0350	0.0512	
	38	0.0150	0.0562	86° 31′
		0.0200	0.0543	
		0.0250	0.0515	
		0.0300	0.0497	
		0.0350	0.0478	
	40	0.0150	0.0521	86° 43′
		0.0200	0.0503	
		0.0250	0.0485	
		0.0300	0.0467	
		0.0350	0.0448	
75	36	0.0150	0.0432	87° 18′
		0.0200	0.0418	
		0.0250	0.0404	
		0.0300	0.0390	
		0.0350	0.0377	
	38	0.0150	0.0407	87° 26′
		0.0200	0.0393	
		0.0250	0.0379	
		0.0300	0.0366	
		0.0350	0.0352	
	40	0.0150	0.0384	87° 34′
		0.0200	0.0370	
		0.0250	0.0357	
		0.0300	0.0344	
		0.0350	0.0330	
80	36	0.0150	0.0284	88° 13′
		0.0200	0.0275	
		0.0250	0.0266	
		0.0300	0.0256	
		0.0350	0.0245	
	38	0.0150	0.0267	88° 19′
		0.0200	0.0258	
		0.0250	0.0250	
		0.0300	0.0241	
		0.0350	0.0232	
	40	0.0150	0.0252	88° 24′
		0.0200	0.0244	
		0.0250	0.0235	
		0.0300	0.0226	
		0.0350	0.0217	
85	36	0.0150	0.0141	89° 7′
		0.0200	0.0136	
		0.0250	0.0132	
		0.0300	0.0128	
		0.0350	0.0123	
	38	0.0150	0.0133	89° 10′
		0.0200	0.0129	
		0.0250	0.0124	
		0.0300	0.0120	
		0.0350	0.0115	
	40	0.0150	0.0125	89° 12′
		0.0200	0.0121	
		0.0250	0.0117	
		0.0300	0.0113	
		0.0350	0.0108	

Contributed by George W. Burley

No. 149, Data Sheet, MACHINERY, December, 1911

:d "Milling Radial Teeth in Cutter Blanks"

MILLING RADIAL TEETH IN CUTTER BLANKS—VII

Angle of Milling Cutter in Degrees	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head
50	42	0.0150	0.1128	83° 44′
		0.0200	0.1092	
		0.0250	0.1058	
		0.0300	0.1022	
		0.0350	0.0945	
55	42	0.0150	0.0941	83° 57′
		0.0200	0.0908	
		0.0250	0.0866	
		0.0300	0.0828	
		0.0350	0.0790	
60	42	0.0150	0.0782	85° 0′
		0.0200	0.0753	
		0.0250	0.0723	
		0.0300	0.0694	
		0.0350	0.0665	
65	42	0.0150	0.0632	85° 59′
		0.0200	0.0608	
		0.0250	0.0585	
		0.0300	0.0561	
		0.0350	0.0537	
70	42	0.0150	0.0493	86° 51′
		0.0200	0.0475	
		0.0250	0.0456	
		0.0300	0.0437	
		0.0350	0.0419	
75	42	0.0150	0.0363	87° 41′
		0.0200	0.0350	
		0.0250	0.0336	
		0.0300	0.0322	
		0.0350	0.0309	
80	42	0.0150	0.0239	88° 29′
		0.0200	0.0230	
		0.0250	0.0221	
		0.0300	0.0212	
		0.0350	0.0203	
85	42	0.0150	0.0119	89° 15′
		0.0200	0.0115	
		0.0250	0.0110	
		0.0300	0.0106	
		0.0350	0.0101	

Angle of Milling Cutter in Degrees	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head
50	44	0.0150	0.1079	83° 4′
		0.0200	0.1037	
		0.0250	0.0995	
		0.0300	0.0952	
		0.0350	0.0910	
55	44	0.0150	0.0900	84° 13′
		0.0200	0.0866	
		0.0250	0.0830	
		0.0300	0.0795	
		0.0350	0.0759	
60	44	0.0150	0.0742	85° 14′
		0.0200	0.0712	
		0.0250	0.0682	
		0.0300	0.0653	
		0.0350	0.0625	
65	44	0.0150	0.0600	86° 9′
		0.0200	0.0577	
		0.0250	0.0553	
		0.0300	0.0529	
		0.0350	0.0505	
70	44	0.0150	0.0468	87° 0′
		0.0200	0.0450	
		0.0250	0.0431	
		0.0300	0.0412	
		0.0350	0.0394	
75	44	0.0150	0.0345	87° 48′
		0.0200	0.0332	
		0.0250	0.0318	
		0.0300	0.0304	
		0.0350	0.0290	
80	44	0.0150	0.0227	88° 33′
		0.0200	0.0218	
		0.0250	0.0209	
		0.0300	0.0200	
		0.0350	0.0191	
85	44	0.0150	0.0112	89° 17′
		0.0200	0.0108	
		0.0250	0.0104	
		0.0300	0.0099	
		0.0350	0.0095	

Angle of Milling Cutter in Degrees	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head
50	46	0.0150	0.1038	83° 23′
		0.0200	0.0985	
		0.0250	0.0948	
		0.0300	0.0900	
		0.0350	0.0858	
55	46	0.0150	0.0857	84° 28′
		0.0200	0.0823	
		0.0250	0.0787	
		0.0300	0.0751	
		0.0350	0.0716	
60	46	0.0150	0.0706	85° 27′
		0.0200	0.0677	
		0.0250	0.0648	
		0.0300	0.0619	
		0.0350	0.0589	
65	46	0.0150	0.0570	86° 19′
		0.0200	0.0546	
		0.0250	0.0523	
		0.0300	0.0500	
		0.0350	0.0476	
70	46	0.0150	0.0445	87° 8′
		0.0200	0.0427	
		0.0250	0.0408	
		0.0300	0.0390	
		0.0350	0.0371	
75	46	0.0150	0.0328	87° 53′
		0.0200	0.0315	
		0.0250	0.0301	
		0.0300	0.0287	
		0.0350	0.0273	
80	46	0.0150	0.0216	88° 37′
		0.0200	0.0207	
		0.0250	0.0198	
		0.0300	0.0189	
		0.0350	0.0180	
85	46	0.0150	0.0107	89° 19′
		0.0200	0.0103	
		0.0250	0.0098	
		0.0300	0.0094	
		0.0350	0.0089	

MILLING RADIAL TEETH IN CUTTER BLANKS—VIII

Angle of Milling Cutter in Degrees	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head
50	48	0.0150	0.0978	83° 39′
		0.0200	0.0936	
		0.0250	0.0891	
		0.0300	0.0851	
		0.0350	0.0808	
55	48	0.0150	0.0815	84° 43′
		0.0200	0.0780	
		0.0250	0.0745	
		0.0300	0.0710	
		0.0350	0.0675	
60	48	0.0150	0.0678	85° 38′
		0.0200	0.0643	
		0.0250	0.0612	
		0.0300	0.0581	
		0.0350	0.0550	
65	48	0.0150	0.0544	86° 29′
		0.0200	0.0518	
		0.0250	0.0493	
		0.0300	0.0468	
		0.0350	0.0448	
70	48	0.0150	0.0424	87° 16′
		0.0200	0.0405	
		0.0250	0.0386	
		0.0300	0.0367	
		0.0350	0.0347	
75	48	0.0150	0.0312	87° 59′
		0.0200	0.0298	
		0.0250	0.0284	
		0.0300	0.0270	
		0.0350	0.0256	
80	48	0.0150	0.0206	88° 40′
		0.0200	0.0196	
		0.0250	0.0187	
		0.0300	0.0178	
		0.0350	0.0168	
85	48	0.0150	0.0103	89° 20′
		0.0200	0.0097	
		0.0250	0.0093	
		0.0300	0.0088	
		0.0350	0.0083	

Angle of Milling Cutter in Degrees	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head
50	50	0.0150	0.0938	83° 55′
		0.0200	0.0891	
		0.0250	0.0849	
		0.0300	0.0806	
		0.0350	0.0764	
55	50	0.0150	0.0778	84° 56′
		0.0200	0.0743	
		0.0250	0.0708	
		0.0300	0.0673	
		0.0350	0.0637	
60	50	0.0150	0.0642	85° 49′
		0.0200	0.0613	
		0.0250	0.0584	
		0.0300	0.0555	
		0.0350	0.0525	
65	50	0.0150	0.0519	86° 37′
		0.0200	0.0495	
		0.0250	0.0471	
		0.0300	0.0447	
		0.0350	0.0424	
70	50	0.0150	0.0405	87° 22′
		0.0200	0.0386	
		0.0250	0.0368	
		0.0300	0.0350	
		0.0350	0.0331	
75	50	0.0150	0.0298	88° 4′
		0.0200	0.0284	
		0.0250	0.0271	
		0.0300	0.0257	
		0.0350	0.0244	
80	50	0.0150	0.0196	88° 43′
		0.0200	0.0187	
		0.0250	0.0178	
		0.0300	0.0169	
		0.0350	0.0160	
85	50	0.0150	0.0097	89° 22′
		0.0200	0.0093	
		0.0250	0.0088	
		0.0300	0.0084	
		0.0350	0.0080	

Angle of Milling Cutter in Degrees	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head
50	52	0.0150	0.0891	84° 9′
		0.0200	0.0849	
		0.0250	0.0807	
		0.0300	0.0764	
		0.0350	0.0722	
55	52	0.0150	0.0743	85° 8′
		0.0200	0.0709	
		0.0250	0.0673	
		0.0300	0.0638	
		0.0350	0.0602	
60	52	0.0150	0.0618	85° 59′
		0.0200	0.0584	
		0.0250	0.0555	
		0.0300	0.0526	
		0.0350	0.0497	
65	52	0.0150	0.0495	86° 45′
		0.0200	0.0473	
		0.0250	0.0448	
		0.0300	0.0425	
		0.0350	0.0401	
70	52	0.0150	0.0387	87° 28′
		0.0200	0.0368	
		0.0250	0.0350	
		0.0300	0.0332	
		0.0350	0.0313	
75	52	0.0150	0.0284	88° 8′
		0.0200	0.0271	
		0.0250	0.0257	
		0.0300	0.0244	
		0.0350	0.0231	
80	52	0.0150	0.0187	88° 46′
		0.0200	0.0178	
		0.0250	0.0169	
		0.0300	0.0161	
		0.0350	0.0153	
85	52	0.0150	0.0098	89° 24′
		0.0200	0.0093	
		0.0250	0.0084	
		0.0300	0.0080	
		0.0350	0.0075	